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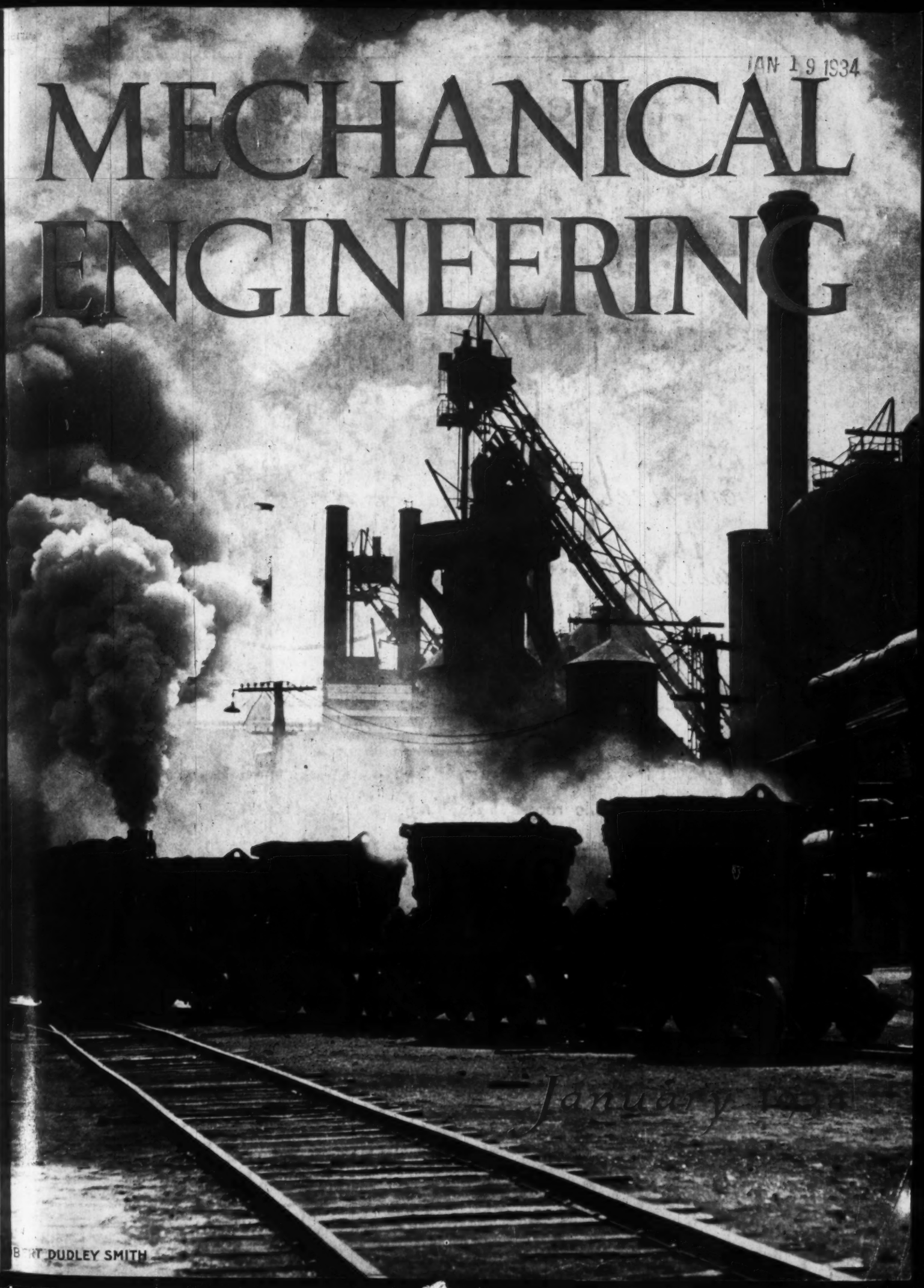
MECHANICAL ENGINEERING



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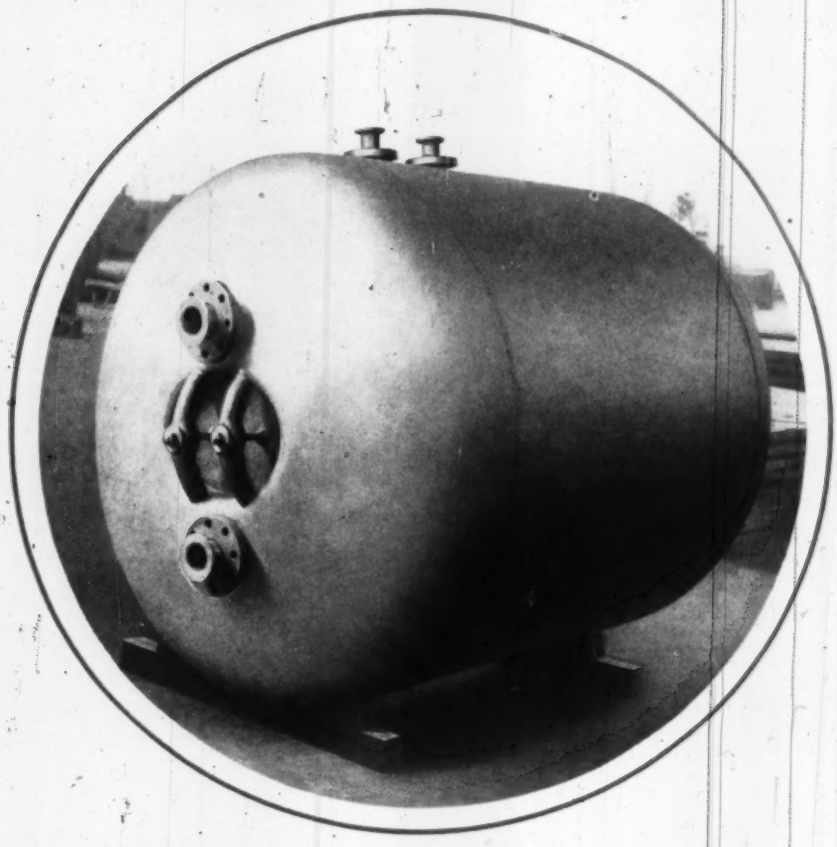

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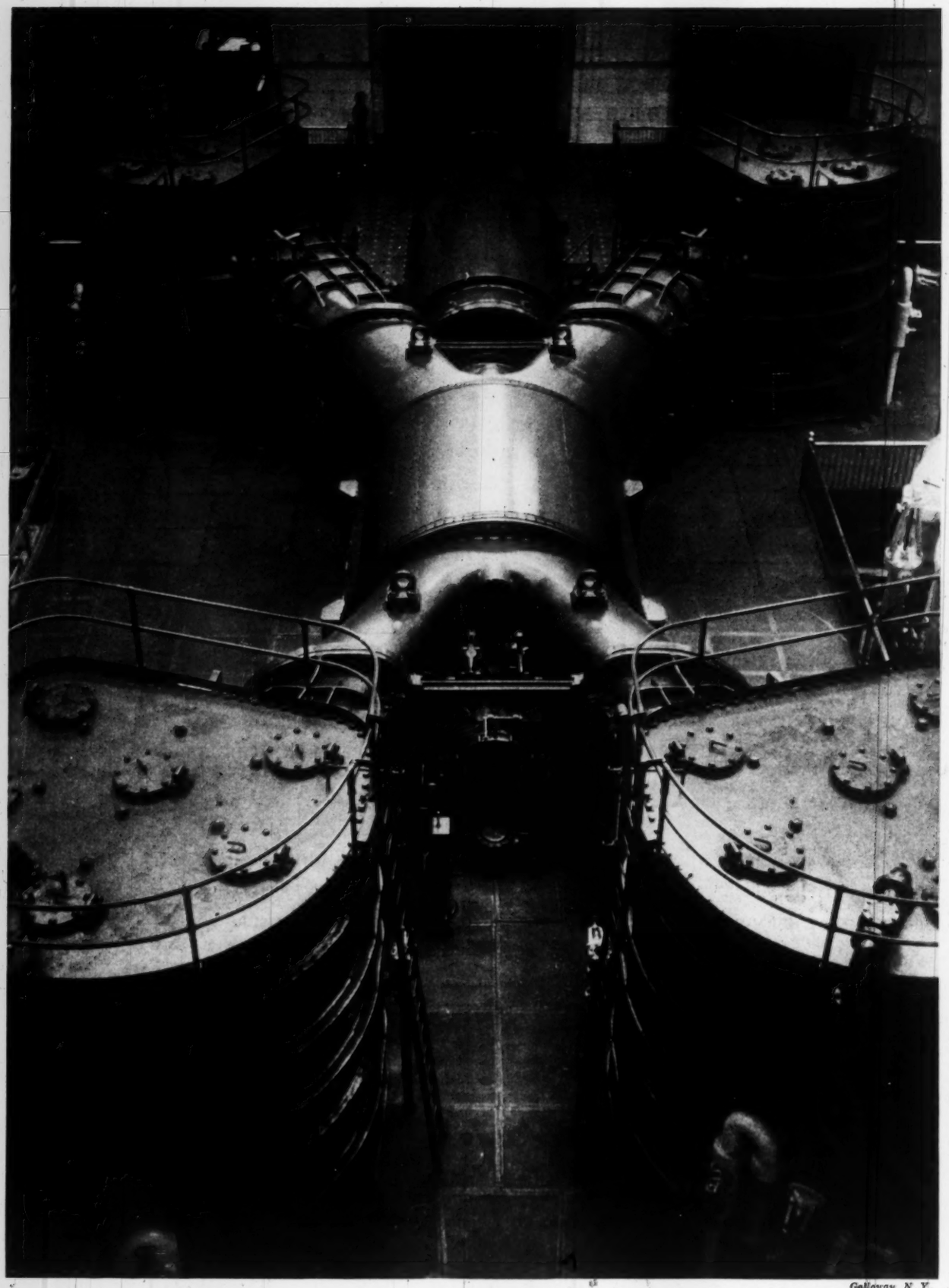

Galloway, N. Y.

Low-Pressure Unit of the 208,000-Kw Generator, State Line Generating Company, Hammond, Ind.

WHITHER ENGINEERING?

By A. A. POTTER[1]

Whither Engineering? Inevitably toward public service—toward the ideal that the engineer is a public official, charged first with a public function, as a lawyer is an officer of the court, responsible for its dignity and honor. Inevitably toward a wider responsibility—toward the ideal that he is responsible for maintaining that balance in the social structure which modern conditions have sometimes so violently upset. Inevitably toward active participation in political affairs where clear thinking and courageous action are badly needed. Inevitably toward a higher type of education—toward the ideal that men shall appreciate their time and understand its trend. Inevitably toward a more closely knit professional organization and a more pronounced professional consciousness—toward the ideal that the wider duties and greater responsibilities of our calling may be met promptly and effectively.

THINKING INDIVIDUALS and progressive social groups must reflect on the past and plan for the future, must take stock of their objectives and seek improved goals. The engineer must analyze his work, study trends, and adjust himself to changing conditions. He has in the past said little about his work and has infrequently concerned himself with public questions. It is timely for us to inquire, whither engineering? What are the thoughts, plans, and attitudes affecting our profession? If we know what is going on about us and what to do, let us consider the means by which we may best apply our knowledge and experience for the public good.

Our times are distinctive, owing to the introduction of science and engineering in the everyday affairs of everyday people. Whether civilized man likes it or not, he is destined to live and to work in an environment affected to an increasing extent by science and technology. While some blame the engineer for the sufferings of our times, the fact is that scientists and engineers should really be credited with the delivery of humanity from the so-called Malthusian doom. Whereas in past civilizations man had difficulty in producing enough to maintain himself above the level of mere existence, the engineer, by applying science to practical uses, assures an abundance of the world's goods for all, given only an effective mechanism of exchange. Present ills are not due to a lack of material wealth to satisfy human needs, but to our inability to distribute it rationally. However, our present problems, serious though they be, should not prove as difficult as those resulting from scarcity and want.

Also, it should be recognized that while the work of the engineer in improving methods of production has reduced employment in some specific cases, the engineer is primarily a creator of both wealth and of opportunities. By proper application of science he has created, during the past 65 years, where nothing was before, such giant industries as those which manufacture automobiles, typewriters, radios, talking machines, airplanes, and telephones, as well as new utilities which are concerned with electric communication, electric transportation, and electric light and power. These are creations, not developments. These are not displacing labor, but are adding new opportunities for profitable employment and happy careers for millions of people. It is reasonable to expect the engineer to develop new industries in the future as he has in the past, creating new opportunities, new jobs, and new careers. He knows what developments are needed and is able to direct the scientific researches and the manufacturing methods to produce results of value.

The engineer has contributed to the general welfare by reducing drudgery, by providing new entertainment, by saving time, and by increasing material possessions. His contributions are being fully appreciated, as to an increasing extent it is realized that America's predominant industrial position is due largely to the engineer. There is a general feeling, however, that he can make additional contributions by taking a greater interest in social and economic problems. Not that the engineer is a miracle worker who can bring about, through his own efforts, a perfect social order, but it is felt that, dealing as he does with facts rather than opinions, he should be able to help with the social problems affecting us. He is skilled in the proper use of science and machinery and is in a position to forestall movements likely to hinder invention and discovery or retard the introduction of improved methods. He may even be able to contribute, by his straight thinking, to a better solution of the social and economic problems which at present confront us.

The engineer has substituted knowledge for guesswork in dealing with technological problems. Has he the wisdom to apply the same straight thinking in his dealings with human relations, social welfare, economics, and finance? It is to be hoped that we are now standing on the verge of a new and better epoch, a period during

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[1] President, A.S.M.E.

Presidential Address delivered at the Annual Meeting, New York, N. Y., Dec. 4 to 8, 1933, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

which the actions of engineers as individuals and as members of a great profession will be influenced still more by clear thinking and by true measurements, and less by irrational opinions, prejudices, traditions, and precedents.

Even though the engineer may not be able to solve, offhand, the problems of human organization, where supposed social experts have apparently failed, it is high time that he seriously consider them. Having developed the necessary technique for almost unlimited production of wealth, he can no longer afford to stand aside while financiers, promoters, and politicians so tragically bungle the problem of its distribution. Primarily, engineering must deal with the technological problems of research, development, design, production, testing, and operation, yet the engineer is becoming more and more interested in finance and is to an increasing extent the directing head of industry and of public works; his success in financial, administrative, and executive posts may be attributed to his talent for dealing with the human phases of industry. He is beginning to interest himself in and to appreciate social and economic trends and is already taking his place among the leaders of our times. Engineers must think more, write more, and talk more on social and economic questions in order to assist in the solution of the major problems confronting humanity.

At the dedication of the Engineering Societies Building in 1907, Dr. Hadley, president of Yale University, said: "Let a man or group of men arise who can add to their technical knowledge a readiness to use that knowledge in the public service, and the people will be ready to put them in charge of affairs and follow their lead." If our profession is to maintain public leadership, we must conscientiously dedicate ourselves to public service and take our rightful places in the affairs of men. This we can do by giving major attention to the following:

ACTIVE INTEREST IN GOVERNMENT AND POLITICS

The engineer must actively interest himself in government and politics, realizing that his contributions to society may be lost without stable government. He must work for good government and for obedience to law, and must apply clear thinking and courageous action to public questions. Furthermore, members of our profession must stand for elective public offices and campaign on well-thought-out policies of action, because a democratic state depends upon participation by the ablest of its citizens in political affairs. Perhaps the greatest contribution of engineers, politically, will come through their familiarity with the technological problems which arise in our civilization, since the government of our cities, states, and nation is very largely concerned with engineering matters.

In these days when unrest is too prevalent to be ignored, the greatest need of this or any democratic government is men and women in political office who think logically, conclude honestly, and act courageously. There is a grave danger that in the present popular and indiscriminating demand for economy and for reduced taxes our cultural advance, our educational system, and our social institutions may be seriously crippled. When we realize that the total cost of maintaining activities indispensable to national welfare, such as education, public health, national defense, good roads, police protection, and scientific research, is less than that which we spend for amusements, cosmetics, and tobacco, we gain perspective in social values. In many localities education, which is our hope for the future and our main bulwark against unwise changes, is being sacrificed to extravagances in governmental activities. This can be remedied only by insisting upon a higher type of political office holder. Education cannot be postponed or its effectiveness reduced without great penalties in the future. It should also be recognized that the consumer demand of two and a half million Americans is fixed every year, and the schools influence the upper limit of nearly half of these; to close or to impoverish our schools is to dry up our markets for a generation at least, a market which can be developed through schools—more schools—better schools. Industry, jobs, and prosperity depend upon customers and the will to have; the determination to be a customer depends upon education. Similarly, reduction of the essentials for national defense, police protection, public health, and research will prove costly in the days to come. The engineers owe it to themselves and their country to utilize their habits of analytical thought in the solution of public questions. In this they must maintain the same regard for truth and fairness as when they deal with their professional problems.

CONTRIBUTIONS TO SOCIAL WELFARE AND ECONOMIC READJUSTMENT

Before the engineer can take his rightful place in the affairs of the nation and contribute most effectively to social welfare and economic readjustment, we, as a professional body, must take an active and leading part in engineering education, insisting on definite educational standards as a qualification for membership. As engineers we have taken little active part in shaping or in directing engineering education, and our engineering schools have not had the serious backing of the engineering profession. What aid has been given to engineering education by engineers has been largely individual and unofficial, and has not represented the concerted thought or the unified action of the profession. It may be expected that the Engineers' Council for Professional Development, representing as it does the leading engineering societies and with its program definitely focused upon the educational preparation of the engineer, will take a definite stand which will insure that the engineer of tomorrow will be fully prepared to take advantage of the new opportunities and responsibilities which are bound to be his. The Engineers' Council for Professional Development provides an opportunity for The American Society of Mechanical Engineers, and for the other major engineering societies

as well, to take a leading part in improving the educational preparation of the engineer. However, it must be realized that reports and recommendations of this Council will not improve the engineering profession without the unified cooperative action of the engineering societies, engineering colleges, and licensing agencies of the various states. The American Society of Mechanical Engineers will, I trust, lead in backing the reports of the Engineers' Council for Professional Development. In the end we may expect that recognition of professional attainment on the basis of education and actual achievement, as tested by examinations, will be substituted for the present haphazard methods of certifying to Society membership. Then we shall find that membership in a society such as ours will unqualifiedly admit to good standing in the great profession of engineering.

A. A. POTTER, PRESIDENT, 1933

The American Society of Mechanical Engineers

At the annual meeting of this Society exactly forty years ago, E. B. Coxe, in his presidential address, decried the tendency of engineering educators to magnify the differences between civil, electrical, mechanical, mining, and other branches of the engineering profession. Unfortunately, this condition still persists, although in practise the work of the engineer is organized largely along the functional lines of research, design, production, operation, and sales, rather than the fields indicated by our engineering societies. Undoubtedly there is still a definite need to revise the engineering programs of study so that the young engineer may have a keener interest in the engineering profession as a whole.

Engineering education is now confronted with two radically different requirements. There is, on the one hand, a very definite demand for engineers particularly well prepared in science, mathematics, and technology. At the same time, engineering colleges are urged to give more attention to social sciences. The demand for a more thorough scientific preparation comes from a realization that the major achievements of our profession can only result when the engineer has sufficient preparation to make full use of the foundations laid by pure science, mathematics, and engineering. The pressure brought to bear upon engineering colleges for more social science comes from an appreciation of the fact that the technical graduate lands flat-footed in a world of men with whom he must cope and cooperate, and sadly needs such knowledge as is available regarding the organization of men into society.

In considering the preparation of the engineer, or, in fact, any educational problem, we must keep two things clearly in mind: In the first place, education is an opportunity to gain knowledge, resulting, we like to think, in greater wisdom. But education is not a guarantee of happiness or wealth or position or security or anything else. In the second place, no amount of education or special training will make two people of unequal talent equal. Leaders are not developed from people naturally inclined to follow. The most any educational program can do is to assist the students to attain the highest level which their natural endowment allows. Mentally and temperamentally, men differ far more than in their physical make-ups, and these differences, being inborn, cannot be overcome by education. When by a fortunate combination of natural ability, environment, and industry a technical graduate proves a leader, a driving force in our profession, we are all apt to class as failures all those less fortunately equipped who suffer by comparison, and are inclined to ascribe the inability of some to reach their goal, or the position desired for them by relatives or friends, to the educational system. Straight-thinking people will not make this error, but will remember that not every entering college freshman is even potentially endowed with the leadership of a Napoleon, the technology of a Steinmetz, the scientific prowess of an Einstein, the inventive genius of an Edison, or the wisdom of a Solomon; most people must derive such consolation as may be had from the reflection that society needs a goodly supply of earnest, conscientious, industrious, painstaking followers who, after all, assume the burden of the world's work.

These qualities, together with worthy ideals of character and conduct, we may properly expect educators to stress in all their contacts with students. We may also expect such an environment in college that the student will be imbued with a keen interest in knowledge and a continuing desire for its achievement.

Aside from preparation for a career, engineering education is the modern type of general liberal education, acquainting the learner, as it does, with the processes, devices, and methods which make our civilization distinctive. Cultured people are those who understand their environment—the world in which they live—and no type of education so directly assists the individual to understand his surroundings as engineering education, which familiarizes one with the machines and the techniques of the modern world. So we of the engineering profession as well as the public at large are interested in making engineering education more effective as a preparation for happy living. As Herbert Spencer stated, "To prepare us for complete living is the function which education has to discharge." This applies to engineering as well as to other types of education.

Some of the graduates of engineering colleges should be given encouragement to continue their preparation for engineering as a career, but a much larger number should be assisted in entering non-engineering vocations with engineering education and possibly even with some engineering practise as a foundation. There is always a definite need for clear-thinking and fact-finding technique in professional, economic, business, and political fields.

A.S.M.E. STAND ON PRESENT-DAY PROBLEMS

Present conditions make new demands upon a professional group. Our own society must assume leadership in the field of mechanical engineering, taking a definite stand in connection with the problems which are confronting our country and our profession. To be specific:

(*a*) The American Society of Mechanical Engineers must discourage the present movement to replace machine processes by hand labor. During recent months an effort has been made to decry capital expenditures, to urge the substitution of human and animal labor for mechanical power and machinery, and to hinder economical methods of production. The present will not be improved and the future will be greatly impoverished if this type of thinking prevails. Surely, we cannot have too many or too effective devices for relieving men from drudgery or for supplying human beings with more comforts. It may be recalled that during the years of greatest prosperity millions of people, even in this most favored land, lacked many of the material comforts which are essential for well-being and happiness. We are far from the saturation point in our need to utilize science and engineering.

(*b*) Our society must take the lead in the stabilization of the so-called durable-goods or capital-goods industries. In 1928 more than half of the industrial workers of the country were engaged in these industries, which comprise tool making, machine making, power production, equipment manufacture, construction, and the development of the heavy industries such as iron and steel, coal, copper, and oil. Activity in these industries is absolutely essential to insure the welfare of a highly industrialized land such as ours. At the same time, however, care must be taken not to have industry overtooled for the production of the market demand for consumers' goods, and it is clearly within the province of a Society such as ours to aid in the preparation and dissemination of accurate statistics regarding production capacity and consumer demand.

(*c*) The American Society of Mechanical Engineers must lead in a policy of rational distribution of the leisure dividends of quantity production. To this end it should encourage investigations of the shorter work week, not only for the manual workers but for the clerical, engineering, and executive staffs as well. Perhaps consumer demand may be fully satisfied with fewer man-hours of work and the resulting leisure more equitably divided than is now the case. Also we should cooperate individually and through our sections with the adult-education programs in the different parts of our land and should definitely become exponents of cultural advance.

(*d*) Our Society should give even greater attention than it does now, in its publications and in its meetings, both national and local, to discussions and papers which are definitely concerned with the scientific, technological, social, and economic problems of the present industrial age. Among the most important of these are the art of industrial management, correlation of agriculture and industry, re-estimating fundamental social values, and aesthetic objectives in engineering design. The engineering society must be constantly contributing to public welfare and must be working to widen the horizon and to enlarge the usefulness of the engineer, so that he may be better prepared to render broad and effective service.

(*e*) The American Society of Mechanical Engineers must keep in close touch with science, as the great engineering achievements of the future will definitely depend upon more scientific knowledge. It must aid in scientific research, in the development of rational designs, in national and international standardization, and in the perfection of labor-liberating machinery to ease the burdens of everyday living.

UNIFYING THE ENGINEERING PROFESSION

Said Sir Francis Bacon more than 300 years ago: "I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereto." Can we today better define the relation of the individual to his profession? Can we as a society hold to a higher objective than the fostering of this attitude?

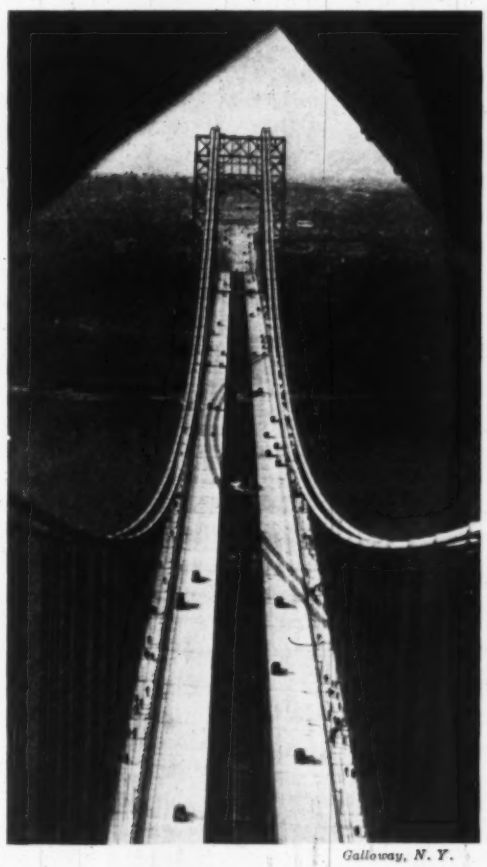
It is gratifying that our own society has always reviewed its own accomplishments with a critical eye and has promptly moved forward in the line of progress. Among the recent advances may be mentioned its leadership in coordinating the joint activities of the engineering profession, its interests in human and economic problems, evidenced by the Society publications, its activity in the stimulation of the capital-goods

industries, and its initiative in organizing the Engineers' Council for Professional Development.

The engineering profession must be unified in its viewpoint, thought, and action. Engineers must assume professional status individually and collectively. An individual becomes a professional man when he regards himself as a public servant first and as a private practitioner second. A society like The American Society of Mechanical Engineers becomes a professional body when, and only when, the conscious object of public service underlies all of its actions. Codes of professional conduct and concerted action in matters of general interest will help to focus the attention of the members of a professional group upon the public aspects of their calling; perhaps the individualistic attitude of some persons may even be changed by the effective public opinion of their peers, thus unifying the engineering profession in its efforts to the public weal.

Until recently the engineer has been an individualist who surveyed, designed, constructed, tested, and operated public works, machines, and tools, and gave little attention to the wider significance of his work or to his social responsibilities. He has worked within the confines of his own field and has had no sense of professional responsibility; neither has he appreciated the strength potential in cooperation among engineers. He has usually joined a professional society when it appeared that his immediate interest would be served, and this in turn has compelled the engineering societies to devote first attention to serving the member's immediate needs, that is, to provide for his technological advance. Gradually this attitude has changed—has given way to the larger conception of an engineering profession; and it only remains for us to consolidate the gains, realizing in formal unified organization the progress already achieved, and to prepare for a rapid further advance.

The work of the engineer is not of recent origin; his contributions date back to the earlier periods of human history, and antedate some callings which have long enjoyed professional standing. Members of the professions of religion, law, and medicine received public recognition when among themselves they realized the public character of their work and developed principles of action or codes of ethics. Engineers must think, act, and appear as a unified and well-coordinated group; a well-knit and well-integrated solid body, not as a collection of individuals, each going his separate way; nor can the profession be properly represented by several distinct societies going their separate ways. This is the time for definite action to perfect the unity and solidarity of our profession, and I am glad that the Founder Engineering Societies are now working on this important problem. We may expect that their efforts will result in some form of central agency, competent to deal with the joint activities of all engineering societies and to pass upon questions of general import without, however, interfering with the technical fields or with the autonomy of the various engineering groups. Engineers have been credited with outstanding success in organizing industrial projects of great magnitude; let us now utilize some of the ability displayed in this work to unify and coordinate our professional advance.



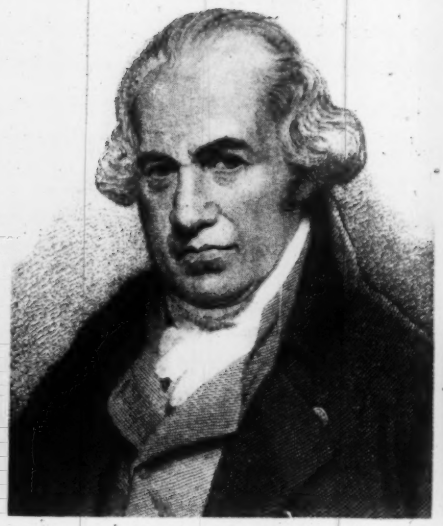
Galloway, N. Y.

WHITHER ENGINEERING?

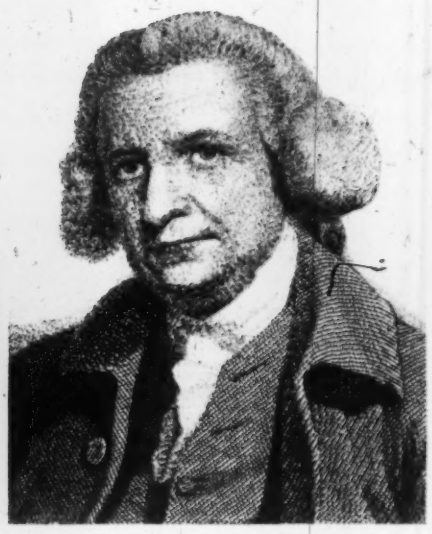
Unifying the engineering profession will enable us to work more effectively on public questions of truly national scope. A central national agency should soon be supplemented by regional or state joint committees to assist governmental authorities in the solution of economic, social, political, and other policy-planning programs. Such groups, composed of engineers, informed and alert, can do the things needful to help governmental agencies in dealing with public questions, particularly with those which have technological aspects.

Whither Engineering? Inevitably toward public service—toward the ideal that the engineer is a public official, charged first with a public function, as a lawyer is an officer of the court, responsible for its dignity and honor. Inevitably toward a wider responsibility—toward the ideal that he is responsible for maintaining that balance in the social structure which modern conditions have sometimes so violently upset. Inevitably toward active participation in political affairs where clear thinking and courageous action are badly needed. Inevitably toward a higher type of education—toward the ideal that men shall appreciate their time and understand its trend. Inevitably toward a more closely knit professional organization and a more pronounced professional consciousness—toward the ideal that the wider duties and greater responsibilities of our calling may be met promptly and effectively.

MATTHEW BOULTON



JAMES WATT



JOHN SMEATON

(Boulton's friendship and backing helped Watt to make the condensing steam engine practicable and commercially possible. Smeaton made valuable improvements to the Newcomen engine, but he is best known as the builder of the Eddystone lighthouse.)

The LIVES *of the* ENGINEERS

An Engineer Historian Recommends the Reading of Biography as a Source of Pleasure, Profit, and Perspective

BY J. W. ROE[1]

IN BACON'S "Advancement of Learning" is the following, mellow with age but sound as ever: "history is of three kinds, according to the subject it propoundeth . . . for it representeth a time, a person, or an action. The first we call Chronicles, the second Lives, and the third Narratives or Relations. Of these, although the first be the most complete and absolute kind of history, yet the second excelleth it in profit and in use. . . . Histories do rather set forth the pomp of business than the true and inward resorts thereof. Lives if they be well written . . . contain a more true, native, and lively representation."

If one would really *feel* the greatness of the British nation and its contribution to civilization, he should spend an afternoon in the National Portrait Gallery in London. Here are hundreds of portraits, beginning with those of Edward III and Chaucer, kings, nobles, commoners, soldiers, writers, engineers, scientists, rich and poor—all who have made the history of the English people. As one stands in some of the rooms—the Elizabethan, the Georgian, and the much-derided Victorian—and looks about him, the thought comes to him: What a strange unrecognizable thing life would be if these and what they stood for were left out of our civilization.

What portraiture is to painting, biography is to history. As Bacon says, "the Lives," well written, have a vividness and an appeal which scholarly histories lack; and what he says is particularly true of engineering biography.

Some years ago, I heard of an interesting argument. A cub lawyer was maintaining the traditional position that only law, theology, and medicine were professions and that engineering was a mere vocation. An engineer present finally said he was willing to maintain the thesis, then and there, before the rest of the company, that the engineers had affected human life throughout the world more profoundly in the last 200 years than the lawyers had in the last 2000. After thinking it over, the lawyer declined to take up the challenge.

All historians acknowledge the tremendous influence of the work of the engineers. They discuss their influence on transportation, trade, production, the standards of living, the Industrial Revolution, and the rise of the factory system—sometimes to praise, sometimes to blame. But of the lives of the engineers themselves they say little. This is a pity because in many cases

[1] Professor, Industrial Engineering, New York University, New York, N. Y. Member, Biography Advisory Committee, A.S.M.E.

Portraits of Boulton, Watt, Smeaton, Brindley, and Stephenson were taken from Smiles' biographies; that of Trevithick from his biography by Francis Trevithick; and those of Nasmyth, Whitworth, and Whitney were furnished by the author.—EDITOR.

RICHARD TREVITHICK

JAMES BRINDLEY

GEORGE STEPHENSON

(The names of Trevithick and Stephenson are imperishably associated with the development of the steam locomotive, while Brindley is remembered as the builder of the Bridgewater Canal.)

these men were interesting. They were strong characters, indomitable fighters whose lives were full of well-won accomplishment.

Engineers have not appealed to biographers as have soldiers, statesmen, and writers. Their work is less spectacular, much of it is technical, and the results are often slow in materializing. First-hand information about them has disappeared by the time the world has become interested in what they did. Newcomen is a case. We would give much now to know more about him, but the material seems lost beyond recall. Few literary men have known much about engineers or cared about them, and few engineers have had the capacity to write well about their own work. Nasmyth is almost the only one to have written an autobiography.

One writer, Dr. Samuel Smiles, has done more than any one else to make known the contributions and the characters of the great engineers, particularly those of England, up to the middle of the last century. The way he became interested in them is significant, as he was not an engineer himself. In a series of lectures to workmen in Leeds, England, on self-help, he found that engineers provided the most apt and vivid illustrations of self-development and of great accomplishment in the face of difficulties. This led to his writing the series, "The Lives of the Engineers," the best group of biographies of engineers we have. It covers Vermuyden, the Dutch engineer who brought drainage and reclamation from Holland to England; Myddleton, who first brought water to London; Brindley, the canal builder; Metcalf, the amazing road builder who was stone blind from early boyhood; Telford; McAdam; Smeaton; and Rennie. These are grouped into three volumes. The fourth covers Boulton and Watt. We all know about Watt, but few realize the debt we owe to Matthew Boulton, whose vision, courage, and business skill carried Watt from certain failure to splendid success. The fifth volume deals with George and Robert Stephenson and the earlier inventors of the steam locomotive.

An inventor, if successful, is peculiarly the product of his time and circumstances. The past is strewn with good inventions made before the world was ready for them. Leonardo's sketches are crowded with ideas which are generations ahead of his time. A successful invention is like the seed in the parable, it must not only be good seed, but must fall on good ground ready for it.

If the modern automobile could conceivably have been invented in the middle ages, the invention would, for a long time, have been practically useless. Neither the materials nor the tools existed with which it could be made, nor were there anywhere roads on which it could have run. At times, economic conditions have called on the inventors, in which case success was rapid; at other times the inventors have anticipated the need and the invention has had to wait until the world caught up with it. In the first case the successful inventors have met with honor and wealth—Watt, Stephenson, Bell, Edison. In the latter case the inventors have died disappointed and defeated in spite of great contributions. Oliver Evans is a splendid example.

One of the greatest benefits from the trip of The American Society of Mechanical Engineers to Germany in 1913 was the interest aroused in engineering history and biography through Dr. Conrad Matschoss, the Verein deutscher Ingenieure, and the Deutsches Museum. The Newcomen Society has been a delight and an inspiration to all who have known its friendly contacts. Its meetings bring out the strong appeal which engineering history has for engineers. There is enough in common in the problems and accomplishments of engineering to make them interesting to all engineers. All are interested in tracing the history of the steam engine through the hands of the military engineer, Savery; the Dartmouth blacksmith, Newcomen, Humphrey Potter, the lazy boy who tied the cords operating the valves; and Watt, the instrument maker. The same is

JAMES NASMYTH

SIR JOSEPH WHITWORTH

ELI WHITNEY

(Three pioneers of machine production; Nasmyth, who contributed the steam hammer, Whitworth, who perfected accurate methods of manufacture, and Whitney, who introduced the manufacture of interchangeable parts.)

true of the development of the locomotive by Trevithick and Matthew Murray and Blinkinsop to George and Robert Stephenson.

Major inventions have usually been developed by a succession of men who have built on each other's work. Many inventions have been made independently by several men in widely separated places, often almost simultaneously. Practically every industrial country has its inventor of the screw propeller and the electric telegraph. As Smiles has pointed out, the invention of the steamboat is claimed for a Spaniard, a Frenchman, an Englishman, two Scotchmen, and four Americans. That of the spinning machine has been attributed to Paul, Wyatt, Hargreaves, Higely, and Arkwright, the balance spring to a Dutchman, a Frenchman, and an Englishman. There is scarcely a detail of the locomotive which has not been subject to dispute, as for instance the exhaust blast pipe, which has been claimed for Trevithick, George Stephenson, Gurney, and Hackworth; the tubular boiler for Seguin, Stephenson, Booth, and James; the link motion for Gray, Williams, and Robert Stephenson. In fact, the cotton gin seems to be the only major invention clearly attributable to one man and one man only, Eli Whitney. The steam engine was in evolution for a hundred years and the steam locomotive for a generation, and almost a dozen men seem to have applied steam to navigation independently. The automobile is an assembly of inventions covering nearly a century.

Who, then, can be considered the inventor of one of these great improvements? Many of them, such as the steam engine and locomotive, should not be spoken of as the work of one man. Where one man is generally associated with a great invention it is usually found that he was the one who first embodied it in such proportions and design as to make it economically available. Fulton is an instance; he was by no means the first to visualize the steamboat or to build and operate one, but he was the first to demonstrate clearly its economic possibilities.

There are a few good general histories of invention and engineering, such as Usher's "History of Mechanical Inventions." Ewbank's history of hydraulics is fascinating. I would recommand also Vowles' "The Quest of Power," from prehistoric time to the present day. But in the main the material lies in biographies and, as indicated above, it is more interesting and vivid in this form. The Engineering Library has scores of engineering biographies, including all which have been sponsored by our own Society. There are collections of lives by Fitch, Howe, Iles, Goddard, and others. The best is the series by Samuel Smiles, particularly the "Boulton and Watt" and "The Stephensons," as well as the autobiography of James Nasmyth edited by Smiles; and a very good book, little known, "Industrial Biographies," which gives the growth of the iron and steel industry and the lives of the great tool-builders, Bramah, Maudsley, Roberts, Nasmyth, Whitworth, and Fairbairn. There are a number of lives of Watt. The best known is that by Smiles. Probably the most complete is that by Dr. Henry W. Dickinson.

The Transactions of the Newcomen Society, beginning in 1920, is a mine of curious and interesting history and biography, both English and American. For those who can read German, the "Beitrage zur Geschichte der Technik und Industrie" is a scholarly and authoritative collection of papers in this field. They have been edited by Dr. Conrad Matschoss, who is widely known in this country, and they reflect his own breadth of vision and catholic sympathies.

Personally, I have had so much satisfaction from browsing in this field that I can wish nothing better for a brother engineer than that he settle himself with a pipe, under a library lamp, and trace the growth of his profession through the lives of those who have created it. It will increase his pride and satisfaction in it.

High PRODUCTIVITY *and the* DISTRIBUTION PROBLEM

By DAVID CUSHMAN COYLE[1]

DAVID CUSHMAN COYLE

THE EVENTS of the past few years have brought to public attention the fact that business is now dependent on markets. Before the War there was a tacit assumption that the problem of industry was how to produce goods at a low cost. Efficiency and economy were believed to be the keys to success. But now the emphasis is shifting to purchasing power. The creation and preservation of a market is now seen to be the key to prosperity. This fact is known in general to everybody, but the implications of this new emphasis on markets are not yet thoroughly understood.

In general, business pays out about as much money as it takes in; that is, in general, business supplies to its employees, stockholders, and creditors about enough money to buy the goods and services that are for sale. The stability of active business depends on a complete circulation of this buying power. Those who obtain their incomes from productive enterprise of any kind must pass on the medium of exchange so that business may receive it again in payment for new goods and services.

There are two established mechanisms by which surplus personal income has customarily been returned to circulation. First and most respectable is the mechanism of saving and investment. Surplus income that is not spent by its primary recipient may be invested in new capital goods. The money is then distributed to the building and machinery industries where most of it appears as wages and makes up an important part of the market for consumer goods. Thus the surplus income of those who have more than they can or will spend is transferred to the hands of workmen who can and will spend it. This is one form of the distribution of income.

The disadvantage of this mechanism is that it leaves behind it a deposit of debt in the form of industrial liabilities equal to or greater than the quantity of surplus income that is distributed. A small portion of this debt is amortized each year, but the major part is allowed to accumulate until a depression occurs, when the excess is removed by bankruptcy. This mechanism of distribution by saving-investment-bankruptcy-paralysis necessarily takes the form of a harmonic vibratory motion. Recovery and prosperity are periods of investment, the building of debt, and the dissipation of the corresponding money through the capital-goods industries; and of active markets well irrigated with streams of buying power. The inflation of bank credit appears in time to aggravate the growth of debt while supplying fiat buying power to business. Collapse and depression, on the other hand, are periods when the worthlessness of the debts is acknowledged, no new debts are incurred for construction purposes, the capital-goods industries are idle, inflated credit vanishes, and business starves for lack of buying power. When enough debt is wiped out by bankruptcies, then the debt-building process begins anew and the cycle repeats. The cycle is a true harmonic vibration in so far as it is due to this particular mechanism, because it has a downward acceleration proportional to its distance above the mean, or an upward acceleration proportional to its distance below the mean. It acts like a weight vibrating up and down on a spring.

The second mechanism for distributing surplus is made up of the system of contributions, voluntary or involuntary, through which those who have extra money pass a part of it over to those who have none. By voluntary contributions the employees of colleges, churches, hospitals, and other service organizations are supplied with buying power and become part of the market for productive industry. By involuntary contributions, such

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as the graduated income tax, another part of the surplus personal income is transferred into the salaries of public servants and wages on public works, where it also becomes part of the market for goods and services. The characteristic of this non-investment type of distribution is that it does not leave behind it any deposit of debt. Your contribution to the Community Welfare Fund brings you a card of acknowledgement, and you know at once that you are not going to get your money back except through the normal processes of business supported by your gift and the gifts of others. When you buy a guaranteed building bond, on the other hand, you do not find out until several years later that you are not going to get your money back. This difference in the time at which the contributor realizes the permanent character of his contribution is important because it affects the periodicity of the process. Investment in excess productivity is a contribution with postponed realization, and is therefore periodic. The distribution of income through recognized contribution and income tax is non-periodic, since in each case the transaction is immediately closed.

SAVING IN THE MODERN WORLD

Saving is possible in the modern world only under certain special conditions. A small amount of the national income, perhaps three per cent, can be saved and invested in new additions to productive plant to take care of the actual growth of industry. This is the first differential of the market for consumer goods and cannot exceed the rate of growth of the consumer market. A small additional percentage of the national income may be rightly invested in building new factories that will bankrupt some of the existing factories. This is progress, and the country can stand as much progress as it can stand bankruptcy. How much that may be depends on emotional factors that cannot be measured in advance, but it is evident that in the Coolidge-Mellon era the total rate of saving and investment was far beyond the limit of safety. This opinion is borne out by the fact that we have not dared to take all the bankruptcy that was coming to us, but have set up the R.F.C. to support the capital market. For the future it is becoming evident that the total amount of saving and investment cannot be allowed to exceed the true growth of productive needs plus the amount of progress for which we are able to face the corresponding capital losses. The national surplus income can be returned to circulation by either of two roads—by investment or by contribution. If a large part of the surplus is recirculated by investment, then business follows a curve such as that which we have observed in the last ten years. The situation indicates the necessity of diverting a larger proportion of the surplus income into contributive or non-investment expenditure.

Thus the degree of periodic dislocation of business will be in part determined by what proportion of the distribution of income is effected through the investment-and-loss mechanism, and what part is effected through the contribution-and-income-tax mechanism. In general, the higher the graduated income tax the more stable the business system and the larger the national income.

The economic law of a highly productive system requires only the continuous recirculation of large incomes, not their elimination. All that is really necessary is that large incomes should be spent in some socially permissible manner, without getting into investment. The income taxes need not confiscate all the surplus; they need only to be set up with suitable exemption provisions that will divert the major part of the surplus into contributions. For the smaller incomes, saving can be kept within bounds only if basic economic security is guaranteed through free public services, insurance, and old-age pensions. We should recognize that these measures are not paternal favors done by an extravagant government, but that by boosting the rate of circulation of the medium of exchange we can greatly increase the annual production of wealth. The economic laws of a system of high productivity seem hard to accept because we were all brought up in the doctrines of Benjamin Franklin, who lived in a system of low productivity. But we cannot escape the necessity of recognizing the change in our environment and adapting our thoughts to new conditions. The laws of nature insist on our obedience. A bucket will hold only so much water, and business will hold only so much investment. Beyond that, you can spend your money, or give it away, or pay it to the Government, or lose it; but there is no way to save it because you have no bucket that will hold it.

STOCK-MARKET INFLATION

Another important factor in the instability of business is inflation and deflation, or the creation and destruction of the medium of exchange. Two among the many varieties of inflation and deflation are of particular interest at the present time. The first is the type for which the conservatives are now hoping—the "normal" stock-market recovery that has always in the past marked the end of a depression period. In this type of inflation, with the revival of what the brokers call "confidence," or general forgetfulness of past experience, the prices of securities are marked up twenty or fifty or a hundred billion dollars. The added price is fiat purchasing power resting on public sentiment like any other kind of paper value. The securities may be used as money, or they may be placed in the bank as collateral for a loan of fiat credit. In many cases the inflated securities are not moved from the bank box but serve as backing for the expenditure of previously hoarded money. In one way or another the injection of fiat dollars into the price of the whole body of negotiable securities adds large quantities of new purchasing power to the markets and stimulates business activity. Many conservative financial experts are hoping for a recovery of this type in the near future.

The disadvantage of the stock-market inflation as a mechanism of recovery is that the fiat money is created entirely in the hands of the investors who happen to

own securities at the moment when they are marked up in price. That is, the money is given exclusively to investors as distinguished from consumers, and it is mainly in the form of surplus income that will not appear as buying power in the consumer market until it has passed through one of the distributive mechanisms. The paper profits on securities appear to the investor as capital funds, and he naturally tends to invest them in new enterprises. The fiat buying power created by a stock-market inflation tends to be distributed to the consumer by way of the investment markets, where it creates a rapid accumulation of debt and a powerful cyclic reaction. There is, in addition, a secondary process that acts in the same direction. It is a fact in this wicked world that when a hundred billion dollars or so of the "root of evil" materializes in the hands of the financial leaders of the nation, they are apt to become so powerful and so apparently respectable that they can influence the Government. The next thing that happens is a reduction of the income tax on the upper brackets, so that more money is poured into the investment, or cyclic, avenue of distribution, and less into the contributory, or non-cyclic, avenue. The reduction of the income tax is the signal for a runaway inflation, leading necessarily to conditions such as those of 1929. By the same token, the control of bank-credit inflation under such circumstances is impracticable, because those whose activities need to be controlled will have become so powerful that they are likely to be found in possession of the Treasury and the White House. All these facts have been proved by the experience of the past ten years. There is no use looking to Germany or to the French Revolution for the effects of running the printing press. We did the same thing before 1929.

In this crisis we have arrived at a new stage in our evolution. The economic system is forced, by drastic changes in its environment, to become a definite organism with a controlled quantity of blood and a heart to pump the blood continuously to all parts of the body. The organism is also forced to develop a definite brain somewhat like the brain in the human body, capable of planning certain kinds of adjustments between the organism and the environment, while leaving other adjustments to unconscious or automatic action. The crisis of mutation is a dangerous one, where birth and death hang in the balance. If we can keep our heads, see clearly what is happening, and press forward in the direction of our destiny, we have a good chance to make a successful passage into our new life.

Such are the characteristics of the customary so-called normal process of recovery, where little if any inflation is done by the Government, practically all the inflating being carried on in Wall Street and the banks. This is popularly called "sound money," and there is no way yet discovered by which it can be controlled.

GOVERNMENTAL INFLATION

The second type of inflation is the governmental or "fiat money" type. In this case the Federal Government increases the volume of money or credit, taking the new buying power for its own use. To some slight degree this effect can be obtained by marking up the price of gold, provided the Government has most of the gold in its own possession. But the most effective method of Federal inflation on a large scale is the sale of Treasury paper or bonds to the Federal Reserve in return for fiat credit. The Federal Government, having become possessed of this new fiat buying power, can then distribute it to the consumer either by investment or by direct expenditure. If the inflated money is invested in self-liquidating public works, the effect is no better than that of a sound-money inflation in Wall Street. Self-liquidating public works, or local projects financed by Federal loans, lay a burden of debt on the consumer or local taxpayer. They have the same effect as business debt in loading the country for a future collapse of business. A Federal inflation, if used to finance public work of this kind, would be almost as dangerous as sound money itself. However, the self-liquidation fallacy, a legacy of the previous Administration, is slowly fading from the public mind, and the present Government is able to begin to handle the distribution of buying power in a less dangerous manner. Last month the President withdrew 400 million dollars from the public works, where they would have had to be used mostly on self-liquidating projects, and turned them over to the Relief Administration, where they can be distributed without the formation of debt. There is some reason to hope that the education of public opinion will have proceeded far enough by January so that the next public-works act may be largely freed of self-liquidation. If that can be done, then the fiat credit made by a Federal inflation can be distributed to business without producing debts that will rest on business.

THERE IS A FAIR POSSIBILITY OF CONTROLLING FEDERAL INFLATION

Another feature of the Federal type of inflation is that there is a fair possibility of control. Governmental inflations sometimes run away, but they differ from sound-money inflations in the fact that under certain conditions the Federal inflation can be controlled, while the sound-money type is always uncontrollable. After the World War, for instance, the heavy Federal inflation that had been used for financing the war was stopped by the appearance of a large Federal budget surplus. The tax structure was strong enough to throw the budget into a surplus, and thus to stop the governmental inflation, but the upper bracket taxes were not sufficiently drastic to prevent the surplus income from getting into investment. The Wall Street inflation

was, therfore, left without restraint after 1924, and it did, in fact, get away and wreck business. The same kind of thing may happen again in the next few years, but there is some chance of controlling the situation provided all the inflation is strictly confined to the Government. Such a policy may require Federal support of the industrial bond market, and at the same time the adoption of effective measures to prevent any considerable rise in the stock market. If, then, the high-bracket taxes are made sufficiently severe, the financial markets can be deprived of the opportunity to share in the unearned increment of the recovery. In that case the Government can, if it is sufficiently adroit, deprive its opponents of the sinews of war and prevent a reaction at the polls and a reduction of the income tax. So long as the tax structure can be preserved in a form that gives the Government a surplus in good times and that also prevents an inflation of the securities markets, just so long the foundation of stable prosperity can be held secure. At the same time, if the Government can, from the start, control the disposal of surplus income and prevent the creation of fiat buying power except in its own hands, those who would normally operate a runaway inflation of bank credit can be excluded from Federal office, and some measure of credit control will be within the bounds of possibility.

INFLATION, THOUGH DANGEROUS, IS THE ONLY WAY TO RESTORE PROSPERITY

All kinds of inflation are dangerous, and yet there is no other way open to us to restore prosperity. The debts resting on industry must be relieved either by bankruptcy or by improving business without building more debt. We are afraid of allowing universal bankruptcy lest we lose the social order and have to suffer a period of chaos. There is no choice, then, but inflation, and all parties are really agreed that inflation is desirable and necessary. The only argument is about who is to do the inflating and who is to get the proceeds. The advocates of sound money would like to have the privilege of doing the inflation themselves, but unfortunately their success in the past has not been good. Private or sound-money inflation always runs away, and its effects are unpleasant. A Federal inflation, on the other hand, may be controlled provided all the necessary conditions are met. A controlled Federal inflation will require bold and drastic action and continuous public support. There is a considerable chance of failure and runaway, but this much can be said for Federal inflation—it is the only method of recovery that has any chance of leading into a stabilized prosperity. These facts are vital in view of the secular changes that have been taking place in the business cycle since the War.

The business cycle has been tending to become more violent during the past twenty years. This fact is not clearly observable from the charts, because there has been only one major swing. There are some financial experts who pride themselves on not knowing anything until they have the statistics, that is, until some years after it has happened; but engineers are not bound by any such rule. Among engineers it is common knowledge that there are several factors now acting that tend toward greater instability of business. One is the increasing mechanization of industry, leading to higher overhead costs and lower labor costs. As Mr. R. E. Flanders has pointed out, the result is an increased violence of the cycle. Another factor is the increased proportion of durable goods produced by industry as it becomes more productive. The durable-goods market tends to be active in good times and to vanish completely in hard times. Another factor is the financial merger of companies that have no mechanical reason for concentrating their operations. Mr. Crosby Field has been active in calling attention to the dangers of this development. The effect of mergers is to increase the disastrous consequences of wrong judgment, to increase sales cost, and to encourage the growth of "stuffed shirts." Moreover, there is a tendency to control output and prices, which, if it is attempted in only part of an economic system, causes the system as a whole to become more unstable. For these and related reasons, the downswing of 1929 might have been expected to extend to depths previously unplumbed.

EXCESSIVE COST OF RECOVERY VIA BANKRUPTCY

A body vibrating on a spring can move up and down with increasing amplitude so long as the spring does not break on the down swing. In the business cycle the spring was bankruptcy. Bankruptcy was the means by which debt was eliminated from business. By bankruptcy we were washed clean of the errors of the past and prepared to rise up and put on new debts as we zoomed upward toward our next tailspin. But if the time ever came when we dared not face the cold bath of bankruptcy, then the business cycle would be ended. Without bankruptcy the spring would be broken, the famous "corner" could not be turned, the old debts could not be washed away, and business could not rise renewed to soar into the blue sky where the cloud castles of finance rejoice the faithful for a moment before they melt away. The only way to preserve the fearful joys of the business cycle was to take our medicine each time on the down swing. But with the amplitude of the cycle increasing, the time was sure to come when we should not dare to let it go to the bottom of its swing. That moment came in 1932, and the R.F.C. was called upon to stop the wave of bankruptcy. That was the end of the strictly self-acting harmonic vibration of business. From that time on the recovery depended on extraneous help supplied by the Government. We cannot have a normal recovery based on Wall Street inflation and creation of new debt because we have not gotten well rid of our previous debts. A Wall Street recovery would necessarily lead quickly to a collapse because there is little room for new debts, and the new investments would soon begin to be overbalanced by the resulting bankruptcies. There is no way out now except to control the volume and the flow of the medium of exchange by means of a governmental agency.

The foregoing analysis covers only a few of the many factors in the present situation, but these particular factors are of central importance. Business cannot operate in a system of high productivity unless the surplus income can be continuously distributed to non-producers and used by them. The mechanism of distribution must be capable of passing a high percentage of the national income without becoming jammed and without producing an intolerable volume of uncollectable debt. The automatic operation of business in a condition of high productivity tends to a rapid accumulation of debt and to increasing instability, calling finally for the permanent intervention of Government as a stabilizing factor. The form of the necessary governmental interference is now being worked out on the anvil of a national crisis.

TWO FUNCTIONS THAT MUST BE ASSUMED BY GOVERNMENT IN ORDER TO STABILIZE BUSINESS

Two functions will have to be assumed by the Government before the operations of business can be permanently stabilized. First and most vital is the function of circulating the medium of exchange. The Government will be called upon by the necessities of the case to act on all stagnant accumulations of unspent money, forcing these masses of surplus money either into non-self-liquidating public works and services or into contributions for semi-public socialized expenditure. By suitable provision for insurance and old-age pensions, the Government will have to guarantee the basic economic security of all members of the economic system, so that the people can freely spend their incomes without fear. By this means the volume of surplus or unspent income can be cut to a minimum and the problem of its disposal reduced to manageable proportions. The economic system, like the animals in their evolution, has reached a stage in its growth where it can no longer feed all its parts by osmosis alone; it is forced to develop a pumping organ to keep its medium of exchange in full circulation. The Federal taxation and spending program, with suitable auxiliary machinery, is that pumping organ without which business cannot adapt itself to its new environment.

The second function that must be assumed by the Federal Government is that of general stabilizer for the economic system. Those industries, such as power and transportation, that require close concentration of control for mechanical efficiency, will naturally drift into the hands of the central Government, as they obviously are doing now. The extreme instability of large operations, when planned with a view to monetary profit, and their devastating effects on business as a whole, will lead to an increasing measure of control by the nation over the operations of concentrated industry. The nation alone can be responsible for the operation of the railroads or the electric power system in the interests of stability, just as the nation is now responsible for the national defense and the post office. The course of events will also lead the nation to plan the operation of those forces that tend to the decentralization of industry. Those forces range from high-bracket income taxes through planned housing and subsistence farms to cheap electricity and Federal highways. By decentralization a large volume of the private business of the country will be removed from the area of extreme instability and restored to the possibility of free initiative. As the quantity of detailed planning needed by industry is reduced within the possible reach of human intelligence, the more unworkable features of the N.R.A. can be quietly relegated to the museum. I agree entirely with Mr. Flanders that national detailed control of all industry in this country is undesirable and impracticable.

By a different treatment for centralized and decentralized industry, we may achieve the necessary control over big business while leaving the majority of our activities free. Thus we may escape the necessity of straining the American temperament with too large doses of what they call in Italy the "corporative state." Finally, the nation will be forced by the pressure of events to assume the duty of managing the volume as well as the circulation of the medium of exchange. The experiments in changing the gold content of the dollar are only a beginning. Far more vital will be the definite transfer to Government of the function of inflation and deflation that has previously been exercised by the stock market and the banks.

GOVERNMENT TO CONTROL MONEY, CREDIT, AND NATURAL MONOPOLIES AND PROTECT BUSINESS

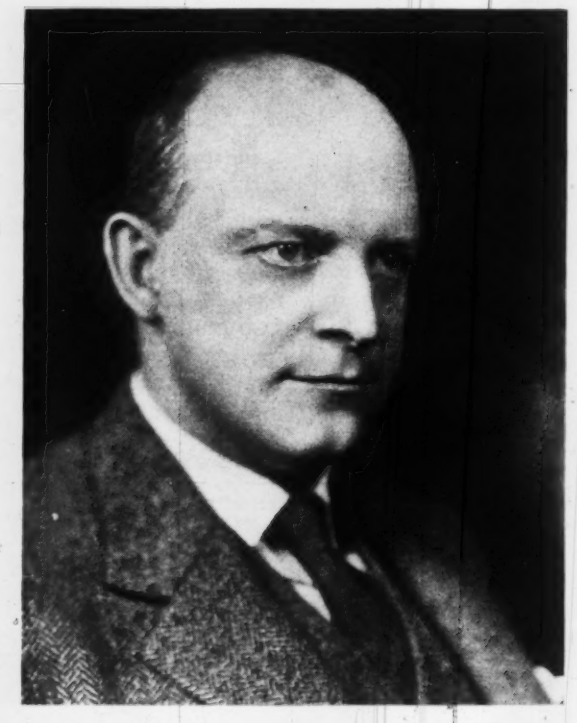
The exact measures that will be adopted cannot, of course, be forecast. American history indicates that those measures that interfere least with the individual activities of daily life are the most likely to succeed in the long run. We may anticipate, therefore, that in the long run the Government will be found exercising the necessary controls over money and credit and natural monopolies, and at the same time protecting the great mass of decentralized American business in a highly individualized freedom of initiative. In general we may regard such present phenomena as the Federal control of small industries as being largely transitory; the really permanent changes are in the financial system and in the final subordination of it to the needs of business.

In this crisis we have arrived at a new stage in our evolution. The economic system is forced, by drastic changes in its environment, to become a definite organism with a controlled quantity of blood and a heart to pump the blood continuously to all parts of the body. The organism is also forced to develop a definite brain somewhat like the brain in the human body, capable of planning certain kinds of adjustments between the organism and the environment, while leaving other adjustments to unconscious or automatic action. The crisis of mutation is a dangerous one, where birth and death hang in the balance. If we can keep our heads, see clearly what is happening, and press forward in the direction of our destiny, we have a good chance to make a successful passage into our new life.

The RECOVERY PROGRAM *and the* CAPITAL-GOODS INDUSTRIES

By HON. JOHN DICKINSON[1]

I AM DELIGHTED to have an opportunity to attend the annual gathering of this great engineering society. The achievements of engineering are, if I may say so, largely responsible for the bulk of the great problems, economic, social, political, with which we are confronted today. If this brave new world that we live in—and which some of us are tempted to think no longer quite so brave—is largely the product of engineering genius, it is time for engineering genius to rise to the challenge and comprehend within its outlook the economic and social consequences of mechanical processes.



JOHN DICKINSON

For such comprehension it is essential to apply somewhat different insights and techniques from those which the engineer applies to his mechanical problems. Social and economic problems are human problems, and fortunately or unfortunately human beings are not machines. They have odd ways of going off in one direction when in the light of all the observable and predictable forces they should go in another. They have a habit of resisting all neat and logical schemes for setting their behavior in order. They have a way of following motives and impulses which lead them in an altogether different direction from that in which they wish to go, or in which they think they actually are going. These perversities of human behavior reduce the slide rule and the calculating machine to futility when applied to human affairs. They result in the fact that frequently the most clean-cut and orderly and logical schemes for social improvement are the very ones which are least adapted to produce the expected results. They make necessary a new type of engineering which today no engineer can properly ignore but which no doubt frequently shocks his sense of the engineering proprieties—a type of engineering which may be described as human or social engineering.

Human engineering, in order to accomplish its result, must give prime consideration to the abiding perversities of human behavior—to the tendency of the normal human unit to act not in a straight line, but in all sorts of devious directions at once under the influence of fears and hopes and passions which get in each other's way and cause eddying currents of action and inaction. Human engineering must, in consequence, often work seemingly in one direction when its real goal lies elsewhere, since only so can it set in motion the forces through which that real goal is to be achieved. I think you can see that in my description of the human engineer I have in mind something not unlike one of the oldest of the professions, the profession of the politician. In this society of engineers I would say a good word for the politician and bespeak for him your favorable consideration; he is the nearest thing to the human engineer that we have today or are likely to have for a long time.

I have digressed into this matter of human engineering because I think it helps toward understanding the program of recovery on which the Administration is working and has been working for so many months. No doubt there are many people who wonder why this or that neat logical scheme of automatic recovery is not tried—why some automatic balance is not set up between this or that unbalanced element in our economy according to a blueprint. The economy program has about as much logic in it as will help it toward its goal of recovery without defeating itself by coming into collision with the illogical perversities of human nature.

It is primarily about the present status of the recovery program that I wish to speak to you tonight. If we as a people are to take toward the recovery program the only attitude which will permit it to work, we must not look at it emotionally, expecting it to accomplish miracles by a mysterious economic magic and then abandoning ourselves to despair because it does not produce a millenium in a month or two—we must take a cold-blooded watchful attitude toward it, assessing its results as they develop and being willing to content ourselves with reasonable gains. That, I submit, is the attitude which should commend itself to engineers. We can hardly expect to repair the ravages of four years in four months or even in six months. To cherish such expectations

[1] The Assistant Secretary of Commerce, Washington, D. C.
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is to revert from the age of reason to the age of medicine magic. From the standpoint of cool-headed observation, what do the indicators show as to the recovery program to date?

In the first place, the total increase in employment since March—the total number of workers who have gone back to work in that period—approximates four million men. The weekly volume of wage payments in September was $64,000,000 above March and is considerably more at the present time. It is estimated that the total increases in wage payments released into the currents of trade between June 15 and September 30 amounted to $600,000,000 over and above what the figure would have been had wages and employment remained at the June 15 level. At the same time it is estimated that the agricultural program will result in increasing the gross income of the farmers for 1933 by about $1,250,000,000.

Concurrently with the release of these new streams of purchasing power into the channels of trade, there has taken place, since increase of purchasing power and increase of business activity are correlative, a decided increase in practically all lines of business activity, in some lines so great as to be almost phenomenal. A short time ago there was a flurry of nervousness in some quarters because this increase seemed to be tapering off and the composite production index had turned slightly downward. This is one of the instances which illustrate the value of a cool-headed persistence in getting at the facts and a refusal to become nervous, since examination proved that the decline in the production index was mainly due to a falling off in automobile and steel production and to the decline in textile production resulting from the overproduction which took place in that line in June from a desire to anticipate the code. Automobiles and steel have subsequently showed signs of recovery, and satisfactory indications of recovery continue in the retail trade and in most lines of consumption goods.

RECOVERY IN THE CAPITAL-GOODS INDUSTRIES

It is about the problem of recovery in one special group of industries that I wish to speak somewhat more particularly this evening—the so-called capital-goods industries in which as engineers you are especially interested. There is, I believe, very general agreement that the recovery program is advancing satisfactorily so far as the consumer goods industries are concerned. When nervousness discloses itself it is generally in connection with the suggestion that recovery in the capital-goods industries has not been sufficiently speeded up.

It is quite true that, from an industrial standpoint, the depression has been very markedly a depression in the capital-goods industries—that is to say, in the industries which produce production goods, such as machinery, transportation equipment, and construction materials like cement, lumber, iron, and steel. The indexes of production and the number of persons employed in these industries have declined since 1929 very much more rapidly and to a very much lower point than has been the case in the industries producing consumption goods, like textiles, rubber, paper, leather, food, and tobacco. For example, in 1932 the production index for lumber had fallen to 25 from a high point of 101 in 1925; the production index for iron and steel had fallen to 31 from a high point of 130 in 1929; the production index of cement had fallen to 51 from a high point of 118 in 1928; the production index of locomotives had fallen to 5 from a high point of 86 in 1926. The decline between 1929 and 1932 was 72 per cent for lumber, 76 per cent for iron and steel, 55 per cent for cement, and 89 per cent for locomotives.

The decline in production to which I have just referred was naturally reflected in a decline in employment. For example, in the cement industry the index representing the number of persons employed declined to 42.5 in 1932 from a high point of 104 in 1925. In iron and steel the decline in 1932 was to 56 from a high point of 101 in 1926. In lumber the decline was to 38 in 1932 from a high point of 101 in 1925. In machinery the decline in 1932 was to 52 from a high point of 116 in 1929. In non-ferrous metals the decline in employment was to 50 in 1932 from a high point of 101 in 1929. In transportation equipment the decline was to 48 in 1932 from a high point of 98 in 1926.

Translating this decline in employment into a composite index for the capital-goods industries as a group, we find that the decline in the number of workers employed was from 100 in 1929 to 50.5 in 1932. In other words, almost 900,000 workers, amounting to practically half of all those employed in these industries, lost their employment in these years. If we turn to the consumption-goods industries, we find a decline of only about 23 per cent in the total number of workers during the same period. This difference in the relative decline of the capital-goods industries compared with the consumption-goods industries is also illustrated by the figures showing the total volume of production of each group of industries in terms of dollars. The total product of the capital-goods industries dropped from $21,000,000 in 1929 to $10,000,000 in 1931, a drop of more than 50 per cent, while in the case of the remaining industries the drop was from $49,000,000 in 1929 to $31,000,000 in 1931, or a drop of only about 36 per cent.

Of particular interest among the capital-goods industries is the construction industry, since its activity lies so largely at the base of the others. The index of construction fell from a high point of 135 in 1928 to a low of 28 in 1932. Translated into terms of dollars, construction was proceeding at an average rate of $552,000,000 per month in 1928, and fell to an average of $118,000,000 per month in 1932. This figure continued to decline until a low point of $53,000,000 was reached in February, 1933. The figure remained at this low level during March and April and then began to rise, reaching $103,000,000 by June and $123,000,000 by September.

The figures which I have presented to you give a rough outline of the decline of the capital-goods industries during the depression. It is truly momentous, and there is no doubt that we cannot consider ourselves as well advanced along the road toward recovery until we can feel sure that these industries, no less than the consumption-goods industries, are resuming their activities on a more normal basis. Here again, however, the recent figures do not leave us without grounds for encouragement. Comparing the first 10 months of 1933 with a similar period for 1932, the production index has definitely advanced in a number of the capital-goods industries such as lumber and iron and steel, and the recent upward swing in construction activity promises, of course, to result in a corresponding upward swing in most of the industries falling in this class.

I would like to call your attention in this connection to the fact that no small part in the catastrophic decline in the construction industry during the winter of 1932–33 was due to the almost complete cessation during that period of public works. Public works have contributed very materially to the volume of construction activities in recent years. The monthly average volume of public-works contracts awarded reached a high point of $80,000,000 in 1930, which declined to $73,000,000 in 1931, and to $42,000,000 in 1932. In February, March, April, and May of this year the figure had declined to an all-time low of approximately only eleven or twelve million per month. The whole effort of the public-works program of the Federal Government has been to start this figure mounting once more toward something like the normal. The results of this effort first made themselves apparent in September, when the

figure had risen to $57,000,000. I am informed that for October it stood at about $80,000,000.

It is not then fair to say that we are not witnessing some resumption of activity in the capital-goods industries. It is true, of course, that there has been no such rapid improvement as in the consumers-goods industries, but there is none the less improvement. This is indicated, for example, by the recent trend in the index of employment for the capital-goods industries; the index in September had risen to 53, or 13 points above the average for the first six months of the year, while in the consumption-goods industries it had risen 17 points during the same period. I submit that this showing should at least remove any proper grounds for radical alarm.

It is only natural that, in the normal course of events, recovery in the capital-goods industries should follow after and be somewhat slower than recovery in the consumption-goods industries. Production of capital goods is, after all, a function of an increased demand for consumption goods. Production of capital goods normally tends to fall off, even before there has been any falling off in the production of consumption goods, but at the moment when the rate of increase in the production of consumption goods tends to slacken. Under these circumstances it has been thoroughly sound for the Administration to direct its initial attention to stimulating the consumption-goods industries, since these supply the market and the purchasing power for the products of the capital-goods industries. With the increase already marked in the activity of the consumption-goods industries, we are beginning to see the effect on the capital-goods industries.

It has been said, with truth, that a definite upward swing in business has, in the past, always been registered by an upward spurt in the activity of the capital-goods industries. However, such a spurt, if it is to be the beginning of a sound development, must rest upon a solid foundation, and under the present circumstances of world economy such a foundation can only be supplied by revival of the consumption-goods industries on the one hand, and by a stimulation of construction activity through public works on the other hand. These are precisely the two directions in which the Government has been exerting its energies. In the absence of the special circumstances which in the past have given impetus to the capital-goods industries, such as the opening up of virgin territories or the exploitation of some new invention, it would appear that we must content ourselves with the more modest and slower results to be expected along the two lines of effort which the Administration is pursuing.

In this connection I should like to raise the question whether we should contemplate within the limits of a sound economic policy making an effort to raise our capital-goods industries to the relative level which they occupied during the recent years of so-called prosperity. A very considerable part of the production of capital goods during the peak years of 1928 and 1929 was exported to foreign countries, the exports of capital goods in those years being at the rate of practically a billion dollars a year. The bulk of these exports was made possible by extending credits to the foreign buyers at a rate and in quantities which practically excluded the hope of repayment. In the same way, a very considerable volume of similar goods went into a type of building construction in this country which was only made possible by a reckless extension of credit based on an overcapitalization of the future. If we desire to restore our national economy to a sound basis, we certainly cannot look forward to a repetition of the type of financial policies which, in these two instances at least, created a demand for capital goods. If we hope to rebuild the structure of our capital-goods industries on a sound and normal basis we must seek to provide some better-fashioned and more modest substitute for these unhealthy types of demand.

I believe we should frankly recognize that we are now facing one of the critical questions of our economy. It is very easy to succumb to the temptation of simply attempting to restore the condition of 1929—liberal credit, mounting paper profits, mounting speculative values. If we do succumb, nothing is more certain than that we shall be headed toward an even greater debacle than that of 1933.

SOUND WAYS OF STIMULATING RECOVERY

On the other hand, if we contemplate a sounder type of recovery, there are from a long-range standpoint at least two ways of promoting, to some degree, a healthy and normal growth of the capital-goods industries. The first of these is a liberal policy of public works, better planned and better timed than in the past. Everybody is agreed on the desirability of an improvement in the timing of public works; the difficulty is to get it applied. That difficulty can only be overcome by the resolute and persistent courage of enlightened opinion. On the other hand, in our eagerness to be free from the burden of taxation many of us are in danger of taking an illiberal attitude toward public spending in general, which would have disastrous repercussions in industry. We have, in fact, reached a stage of economic organization where public bodies must continue to buy large quantities of the products of our industries if those industries are to function normally.

A second sound way of stimulating and maintaining a normal healthy growth of our capital-goods industries lies largely in the hands of our business men and industrialists themselves. It consists in the adoption by business concerns of an orderly and progressive policy of replacing obsolete equipment. In the past this policy has been too frequently tied up with and defeated by a reckless borrowing policy. If replacements are to be continually financed by the borrowing of new money, there is no wonder that they do not greatly appeal to conservation concerns. A sound replacement policy must go hand in hand with a sound policy of amortizing existing investment and building up out of current income a reserve from which replacements can be made without new debt accumulation.

When we turn from these long-range measures of possible reform to the immediate question of recovery, there is another important respect in which the key lies largely in the hands of industry itself. I refer to the matter of prices. I do not think that there can be any doubt that on the whole prices in the leading capital-goods industries did not come down as far or as fast as in many other industries. To what extent that fact led to a decreased volume of production and to correspondingly higher unit costs, you know better than I. In recent months industries have taken advantage of the codes to raise their prices very considerably. Two things would seem clear: (1) that increased prices accompanied by decreased volume do not constitute a very promising avenue toward recovery; (2) that decreased volume leading to increased unit costs leading in turn to price increases constitutes a vicious circle making against recovery.

In conclusion, let me say that the National Recovery Act places a very powerful instrument in the hands of industry. It is a weapon which industry can use to its own undoing unless it is actuated by a careful and well-reasoned economic understanding. Short-sighted panaceas, oversimplified remedies are as dangerous when applied by business to itself as when applied by government. Let me urge upon you to approach the problem of those industries, not with a short-sighted desire for the largest immediate profits, but in a spirit of statesmanship.

INDUSTRIAL MANAGEMENT *and the* RECOVERY PROGRAM

By VIRGIL JORDAN[1]

MY SPECIFIC purpose is to describe realistically some of the more fundamental aspects of the situation of American industrial management under the economic policies of the present Administration. I am not concerned with the abstract merits or defects of these policies as academic theories or with the virtues or weaknesses or the motives of the persons administering these policies. These are important questions, but only in relation to the practical problems which they create for industrial management, which is the primary subject of consideration here.

VIRGIL JORDAN

By way of preface I would point out that the relation of Administration policies to industrial management is important to the Administration as well as to management, for several reasons. In its economic policies the present Administration has the purpose of reconstructing our economic and industrial system, as well as the purpose of promoting recovery from the depression. To some of those in the Administration the purpose of reconstruction is probably more important than that of recovery. In some cases it is possibly so much more important that they would prefer to postpone recovery if that would make it easier to carry out promptly the purpose of reconstruction, and they might even be willing to sacrifice or prevent prompt recovery because the conditions so produced would provide unhampered opportunity for reconstruction. Nevertheless, politically speaking, some measure of recovery prior to complete reconstruction is probably necessary. At least I shall give the Administration the benefit of the doubt that prevails on this point and assume that it desires some recovery.

THE FUNCTION OF PRIVATE ENTERPRISE IN RECOVERY

If this assumption is justified, then the following categorical statements may be made: First, that full reemployment and restoration of earnings of workers depend upon resumption of activity of enterprise under private management. It would be unnecessary to state and explain this obvious fact if it were not generally forgotten in current discussion of the problem of recovery. Theoretically, of course, the Government might assume the ownership and operation of industry and business and provide employment and wages for everybody; but it is probably not prepared to do this immediately, and under present conditions the larger part of the employment and payrolls must be provided by individual business enterprises under private management. The Government could probably employ a considerable part of the unemployed in public work and pay them out of public funds, but it could do this only if the rest of the population were fully employed in private enterprise that produced some net income out of which the Government by taxation could secure the necessary funds to employ and pay the rest. It might be able to secure such funds for a time by borrowing, but employment on public works would cause more private employment. This would be possible only so long as the remainder of private enterprises yielded a net income for investment or for building up bank resources. It might print the necessary currency for a while, but this would only be a means of indirectly taxing the income of those privately employed. Immediately and ultimately, therefore, the possibility of recovery through full reemployment depends upon the management of private business, unless the Government is prepared to run all business enterprise itself.

A second reason why industrial management is important for recovery lies in the fact that full reemployment is probably not possible without restoration of private investment in improvement and expansion of existing enterprise or initiation of new enterprise. We cannot fully employ everybody making and distributing goods and services currently consumed. A considerable part of our working population must be employed in producing machinery, equipment, and other facilities needed for further production of goods and services, either by way of replacing what is worn out or obsolete or by adding to the existing facilities, or creating facilities for producing new things. Somebody has to assemble and invest money or credit in such production and manage the investment when made. The Government might conceivably loan funds for this purpose for a while, but those funds in the end could be secured only by taxing or borrowing or expropriating through inflation funds that private individuals have saved out of their own enterprise.

[1] President, National Industrial Conference Board, New York, N. Y. Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., Dec. 4 to 8, 1933, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Finally, private enterprise will not employ people in any occupation, and private investments will not be made so as to employ people in the capital-goods industries unless there is some expectation of profit. Such profit may not always be realized, and in fact cannot always be realized; but individuals must at least be free to take a chance on losing their money with some assurance that if they succeed in making any they will be permitted to have it to spend, invest, or waste in their own way. Our business system is a profit and loss system in which speculation is the essential element. If there is a certainty of loss, or if it is certain in advance that profit will be prevented, business management and investors will not attempt to make any, and the working population will not be employed unless the Government employs them. Perhaps it will ultimately be possible to reconstruct our economic system so that everybody will be employed and capital provided by the Government, but until this is done, and so long as we are interested in recovering from the depression under our present business system, industrial management and investment in private enterprise will have to provide jobs for the unemployed and keep the employed population working. This simple fact must be the starting point of any attempt to interpret the situation of industrial management under the present policies of the Administration.

THE POLITICAL AND PSYCHOLOGICAL BACKGROUND OF THE RECOVERY PROGRAM

As the next step it is necessary to understand the political and psychological background of the situation in which industrial management finds itself under the recovery program of the Administration. In this I am speaking not merely of the Industrial Recovery Act, but of the whole legislative scheme of which this act is a part and of the economic philosophy and public attitude that are embodied in this legislative scheme and its administration.

The Industrial Recovery Act in itself is only one element in an elaborate structure of legislation which is not yet quite complete, but which already embodies a comprehensive and clearly defined economic philosophy, with general grants of power to individuals to apply this philosophy through Federal agencies. These agencies are not clearly specified as to personnel and functions but, generally speaking, may be created *ad hoc* to carry out the general purposes in view and may create a new body of law or regulation to this end. The Agricultural Adjustment Act, the Securities Act, the Banking Act, the Railroad Coordination Act, together with the legislation creating the Tennessee Valley Authority and the Public Works Administration, are the principal other parts of this legislative structure, and the Industrial Recovery Act cannot be considered separately from them. The problems facing industrial management do not arise solely from the Recovery Act or its administration, but rather from the whole legislative scheme of which it is a part.

This structure of legislative authority and administrative machinery is essentially an expression of two things that are of prime importance in interpreting the position of industrial management in the United States today. In the first place, they are an expression of an attitude of the public toward industry. This attitude is in part the natural outcome of four years of depression, declining prices, unemployment, and business losses; but it has deeper sources than that and represents a state of mind that has probably been developing for at least a decade among some groups of the population and possibly longer for others. The best way to describe this attitude is to call it, in somewhat technical language, a powerful, widespread and deep-rooted anti-industrial complex or psychosis. Although, as I shall indicate, it has its intellectual rationalization, it is fundamentally an emotional attitude, and it is not confined to any special class or group but seems to be shared by the general public, by labor and labor organizations, by farmers, and by a considerable part of professional industrial management itself.

THE ANTI-INDUSTRIAL COMPLEX

This anti-industrial complex out of which, politically speaking, the general grant of power to the Administration was really derived and upon which its whole program is built, involves several closely related ideas, or rather states of mind. These ideas are not new; they have often been expressed in outbreaks of anti-industrial agitation since the very beginning of the power age; but they found their clearest statement in the writings of Sismondi, Rodbertus, and Karl Marx, and they have been evolved, though the writings of more modern authors, like Hobson abroad, and Foster and Catchings in America, into a system of more or less accepted economic theory embraced by a special school or sect of economists with which the Administration has happened to associate itself.

At the bottom of them is the feeling that there is something inherently dangerous to human welfare and social progress in the free development of industry by the use of power machinery. The Frankenstein myth is the folklore of this state of mind, and it seems to have been accepted by the present Administration as a basis of public policy for the first time in any modern nation.

This vague feeling of the potential menace of power-driven machinery in the modern industrial system has developed, in the public mind, into a number of more or less dogmatic beliefs. In simplest terms, the victims of the anti-industrial complex accept as axiomatic the assumption that industry is to blame for the depression, or in other words, that the depression was due fundamentally to inherent defects in our industrial organization and deficiencies in industrial management. With this preconception is associated the notion that modern industry has automatically become a sort of self-operating, perpetual-motion system whose capacity for producing goods and services chronically tends to exceed the power to consume them. Beneath the whole anti-industrial psychosis there is the axiomatic acceptance of the idea of the ever-present danger of universal overproduction, the assumption that the problem of producing goods and services has been completely solved, and that the only important unsolved problem of modern society is the control of production and the distribution of the product.

Out of this grows the conception of the consumer as the essential element in our economic system. The rôles of the inventor, investor, and enterpriser in economic advancement are minimized, disregarded, or regarded as a menace, and the "consumer," the machine operative, and the farmer are envisaged as the triumvirate who must henceforth determine the destiny and dictate the direction of industry in the interest of society as a whole. The anti-industrial complex conceives the consumer as a new kind of king by divine right and sets up a sort of absolute monarchy of consumption for the rule of our economic machine. Under the anti-industrial complex of the present, this consumer king, of course, is always only the current consumer, living here and now, in the pure spirit of *carpe diem;* he is never the consumer of tomorrow, or next year, or the next generation. Industry exists and industrial management acts only in relation to the commands of the consumer of today. In spite of the fact that the prosperity of each generation is in large part the product of its effort to provide for the prosperity of the next generation, to the anti-industrial complex posterity is of little importance because "it has never done

anything for us," and consequently any concern for future consumption, through saving, investment, industrial improvement, or otherwise is felt to be irrelevant and even vicious.

DELUSIONS OF THE ANTI-INDUSTRIAL COMPLEX

Out of this economic Epicureanism which underlies the anti-industrial complex of the present has grown a great variety of popular delusions and curiosities of public behavior, which it would be out of place to detail here. The most important general result is the almost universal acceptance by the American public of proposals for control of industrial and agricultural production directly or indirectly by government as a means of increasing the purchasing power and standard of living of industrial and agricultural workers. The concept of government, especially of the Federal Government, as a passive agency created by the public for the sole essential purpose of providing for the protection of life, property, and public order is completely abandoned—indeed, attempts to perform this function are even resented; and instead the Federal Government is conceived as an active, independent economic agent which has the power of originating wealth itself over and above what the efforts of individual citizens can produce, so that it can and should raise the standard of living of the public to a level higher than they could otherwise attain for themselves. In fact, this feeling goes so far as to imply that industry and individual enterprise would depress the standard of living and destroy wealth, were their influence not offset by the creative power of government.

The anti-industrial complex, however, is not so much concerned with raising the standard of living or increasing purchasing power as it is with guaranteeing economic security and stability. This anti-industrial psychosis is essentially the expression of anxiety that usually accompanies declining enterprise and creative power in a people. It puts a premium upon assurance of security by some external agency or authority, some *deus ex machina*—which, in the present situation, for instance, will guarantee wages without work, income without effort, and profits without enterprise. In fact, work, effort, or enterprise by individuals comes to be considered a dangerous element because it threatens the passive security of others. All competition becomes suspect of itself and is automatically called "cut-throat" or "unfair" because it makes trouble for somebody and creates the necessity for effort on the part of others. In this respect the anti-industrial complex, as it appears among industrial management, is a reflection of fatigue, exhaustion, or creative impotence, and its expression in the whole Administration program justifies calling this program the "tired business man's revolution."

In a broader and deeper sense, the old delusions which underlie the New Deal and its anti-industrial psychosis are partly an indication of the creative exhaustion or sterility of an older generation of business leaders who did their work in the development of American industry years ago but who are still largely in direction of its management because so many of the next generation that would normally have succeeded them were destroyed physically or mentally by the War; and they are partly a reflection of the sense of creative frustration that is suffered by the youth of today, who were children during the War and whose lives have been like a waste land ever since. Deep beneath the disillusionment that lies behind the New Deal, in its search for security, its distrust of individual initiative and ambition, its sadistic desire to subject these impulses to arbitrary authority, its infantile fear of competitive effort, and its impulse to make great groups of human beings the material of pretentious Utopian plans that promise easy and permanent prosperity—in all these things we are paying the price for that "lost generation" which disappeared in the physical and moral destruction of the War. Europe has had to pay a heavier price than we, and the fascism, communism, or state socialism that nearly every country abroad has seen since are reflections of it. The anti-industrial complex of the New Deal indicates that, somewhat late, and perhaps more cheaply, we too are finally paying the spiritual price of the catastrophe that destroyed an entire creative generation.

Perhaps the clearest and most dramatic indication of the state of mind that underlies the New Deal may be seen in the repeated assertion that the "frontier" of free enterprise has permanently disappeared in America, that the era of opportunity for advancement and even for security by individual effort is at an end, and that in order to survive, America, like the poverty-ridden countries of Europe, must regiment itself in Spartan discipline to save and share the few economic crumbs that are left us. In a land whose natural resources and possibilities of expansion are still scarcely scratched as are ours, could any leader successfully preach such a gospel of the stabilization of poverty, save to a people whose creative power had been temporarily crippled by a profound spiritual catastrophe?

THE ECONOMIC THEORIES OF THE "NEW DEAL"

But in the ideology of the New Deal there is something more than the mere emotional anxiety or anti-industrial hysteria, upon which the Administration's grant of political power is based. This second element, out of which the practical policies of the Administration have been developed, is an elaborate and close-knit structure of economic theory which is accepted as an explanation of the depression and provides the recipes for recovery and subsequent stability. As I have said, this body of theory is not new, but it has been highly elaborated in recent years—largely in academic vacuum, like most economic theories—by a special sect of economists, with some of whom the Administration happened to associate itself. It has been accepted bodily by the Administration, apparently without any attempt to relate it to the existing body of traditional economic theory, or to verify its postulates by statistical analysis. The fact that it was inconsistent with traditional theory made it *a priori* politically appropriate to accept it, and it was assumed that statistical verification would be forthcoming as soon as the central statistical agencies to be set up with compulsory powers of securing information could function.

In accordance with the emotional predispositions that put it in power, the depression, as I have said, is interpreted by the Administration as having been due fundamentally to inherent defects in our industrial organization and deficiencies in industrial management. These defects and deficiencies, according to official theory, consist essentially in the fact that the existing organization and management of the productive industries inevitably result in a distribution of the national income and the national wealth which is both uneconomic and inequitable. According to the underlying theory of the Administration program, this maldistribution consists in the facts, first, that too large a proportion of the national income goes to those who work in cities and too small a proportion to those who are engaged in agriculture or the production of raw materials, and second, that too small a proportion of the national income goes to wage or salary workers who must spend most of their income for the needs of daily life and too large a proportion goes to investors and owners or managers of enterprise who cannot spend all their income but must reinvest most of it.

This maldistribution of income arises, in the view of the pundits of the Administration, not from differences in the productivity of the different economic groups or factors in produc-

tion, but from (1) the tremendous and automatic productivity of modern power-mechanized industry, and (2) the effort, under private individual initiative and corporate enterprise, to extract excessive profit from this productivity and prevent the consumer and worker from enjoying its full potential benefit. In the ideology of the New Deal, modern industry is conceived not only, as I have said, as a sort of self-operating perpetual-motion mechanism with unlimited capacity of production, but as something superior even to a perpetual-motion machine in that its capacity of producing goods and services tends chronically to exceed the power to consume them because the aggregate expenses of production do not equal the price of the product, so that the output in income is consistently greater than the input of expenditure yielding a permanent net profit which is never consumed, but constantly accumulates in the hands of a small group. This maldistribution of the national income leads inevitably to chronic overinvestment in productive facilities, constantly creates excessive productive capacity, prevents full exchange of goods between economic groups, and results in periodic or persistent overproduction. Speculative booms in the security markets and the subsequent collapses are another inevitable consequence of this inequitable or uneconomic distribution of the national income.

Proceeding on these assumptions, several lines of action are clearly indicated in order to promote recovery from the depression and to prevent future depressions. There must first be brought about a redistribution of the national income as between farmers and the urban population. This is to be done, first, by lowering, writing off, or shifting part of the debt burden of farmers to the urban group or to the public as a whole, either through inflation or through more direct measures of Federal refinancing; and, second, by transferring part of the income of city people to farmers through measures that raise or fix the price of farm products and pay bounties to farmers out of taxes collected from the city population in order to persuade them to curtail production. In connection with this transfer of income, some systematic governmentally controlled curtailment and allocation of agricultural production must be instituted.

As regards industry, wages must be raised, hours of work shortened, profits and managerial salaries reduced, prices of industrial products brought into proper predetermined relationships to other prices, and production and investment in new productive facilities controlled. In addition, through high income taxation, a larger proportion of the surplus investment income must be drawn off and expanded by the Government as wages in the construction of public works and the provision of various public services. Finally, since some people still may save, or some few business concerns make profits by special enterprise in spite of every handicap, the investment of such surplus income as may still accumulate must be directly controlled and allocated so as to prevent the creation of excess productive capacity.

MONETARY THEORIES OF THE "NEW DEAL"

It is necessary to consider separately the monetary ideas of the Administration, which I mentioned in passing only in connection with its agricultural policy, out of which, in their political significance, they originally arose. It is difficult to interpret clearly their relation to the rest of the ideas underlying the New Deal, for their application has involved a great deal of confusion and conflict within the Administration, as well as outside it. The New Deal program recognized vaguely the possible importance of the part that general monetary factors, specifically a general change in the value of money, may have played in the depression. It was forced to do this by the political pressure of the agricultural group upon whom it has depended for a principal part of its support, and who, as the largest single organized voting group of debtors, had been persuaded of the imperative need of inflation or revaluation of the currency for their relief.

From the outset, therefore, the Administration has been more or less vaguely committed to efforts to raise the price level of farm products by monetary action as a means of relieving the debt burdens of farmers. But in the first six months of the New Deal there was a crucial struggle within the Administration between those of its advisers who viewed action on the monetary problem along inflationary lines as the key to prompt recovery or as, in fact, the only essential element in the Administration program, and those who regarded reconstruction of the economic system by regimentation and detailed determination of price and income relationships as the primary objective and feared that a reflation of the price level by monetary means would lead to such prompt recovery and free expansion of enterprise in every direction as to restore and revitalize the preexisting system and rob them of the opportunity to remake it. The latter were reinforced by a few old-fashioned "laissez-fairies" who somehow found themselves among Administration advisers, so that for a while the lines of conflict were not definitely drawn; but for six months this fundamental opposition in the Administration program was evident to any observer with insight into its significance and accounts for the vacillation in the Administration's monetary policies during this period.

This conflict, I believe, has now finally resolved itself into a reconciliation and consolidation of the two points of view within the Administration, by alignment of the agricultural and labor groups in favor of *both* monetary control and direct regimentation as against the business, industrial, and banking groups, a few of whom favor inflation because they feel it would facilitate a return to laissez-faire, and most of whom are more afraid of inflation than they are of regimentation. This is a curious outcome, but it is quite consistent with the inherent implications of the ideas of the New Deal and is most important for a clear understanding of their significance.

THE RESULTS OF ECONOMIC REGIMENTATION AND MONETARY POLICY

Aggressive pursuit of inflationary policies during the first six months of the Administration would undoubtedly have upset the plans of the regimenters, and for several months the natural effect of leaving the gold standard and of the mere promise of inflation threatened to do so; but by now the machinery of regimentation and control is almost fully set up, and there is nothing to fear on that score. The essential fact is that the monetary policy of the Administration has now been absorbed as an integral part of the program of economic regimentation and control and as a potential instrument of nationalization of industry. Those who favor inflation because they feel that it will bring an early return to laissez-faire are likely to be disappointed; and those who fear expropriation by inflation more than they do expropriation by regimentation are also likely to be disappointed, because they will probably be expropriated both ways or anyway. In their present form and application the monetary policies of the Administration, like its other policies, are based upon the same anti-industrial complex out of which its political power emanates and express the same structure of economic theory which its whole program embodies. They involve the same emotional antagonism toward saving, capital investment, and industrial enterprise, the same fear and prejudice toward the productivity of machine industry and the financial processes underlying its development; and

they, together with the other parts of the Administration program, unite the great debtor groups—the farmers, the unemployed, the small home-owners—in a common purpose of compelling a redistribution of wealth and income by expropriation of those whom they regard as the exploiting creditor group—the employers or owners of industrial enterprise and the bankers.

In response to this emotional impulse and in pursuit of this structure of economic theory, the general powers of monetary manipulation granted the Administration will be applied in conjunction with its other powers of direct economic control, with the broad but definite purpose of redistributing wealth and income by expropriating creditors and relieving debtors at home and abroad. This is to be done (1) by depreciating and controlling the exchange value of our currency, which diminishes the real value of foreign-debt payments and tends to raise the prices of farm products and of industrial raw materials; (2) by directly controlling the rise in price of domestic manufactured goods so that they will not rise as fast as farm products or wages; and finally (3) by distributing to wage earners through public expenditures or to debtors through public loans, funds secured by forced lending to the Government of savings or bank credit which are prevented from flowing into private investment or abroad. This process constitutes essentially a capital levy, and a redistribution of income as between city and farm workers, or as between investors and wage earners, which is strictly in accord with the basic purposes of Administration policy. It is true that this process inevitably implies expropriation of many individual creditors of savings banks, insurance companies, and industrial concerns who are also wage earners and farmers with small savings and investments or insurance policies; but this is unimportant in relation to the fundamental purpose of dissipating or expropriating the larger aggregations of capital which are considered the essential evil of our industrial system. The Administration has also declared its purpose of stabilizing the price level for the future at some fixed point through monetary manipulation after the initial expropriation is accomplished; but the objective of preventing future concentration of wealth and income is more vital from its point of view, and this can be more effectually accomplished under its program within a stable average price level by direct control of relative prices of individual commodities through the recovery-administration and the agricultural-administration machinery and by the control of savings, credit expansion, and the flow of investment funds into private enterprise through the banking legislation and the Securities Act.

Finally, of course, it will be possible to use the monetary powers granted the Administration, in conjunction with its other powers, to secure a transfer of ownership or effective financial control of essential industries from private hands to public authority. Whether or not it is the conscious intention of the Administration to use these powers, together with its other powers, for that purpose, there are several ways in which the result may come about almost automatically in consequence of their use in other connections, so long as a general antagonism to private enterprise underlies the entire Administration program. I leave out of account the very remote possibility of hyper-inflation of the German type, which, among other things, destroys working capital of industrial concerns, prevents its replacement from private sources, and renders them ultimately entirely dependent upon Government. The special process of inflation that is being applied here is an extension of state capitalism by budgetary expansion. Private savings and bank credit are being drawn off for investment through public channels in loans to farmers, home owners, banks, other financial institutions, railroads, and local governments. Through these loans private capital in these fields is being replaced or reduced, and the Federal Government is securing prior liens upon private-capital assets, under which it assumes authority over various details of management, such as production, rates, prices, executive salaries, and wages. Furthermore, by Federal loans for construction of power plants or distributing systems, private investments in utilities are being destroyed and replaced by Federal public investments. Another important accompaniment or objective of the process of budgetary inflation is Federal control of state and local affairs through loans to local governments, which are a prior lien upon local tax income. Finally, the problem of securing maximum reemployment under the conditions imposed by industrial codes may require Federal loans to smaller, unfavorably situated enterprises to finance payrolls or purchase equipment, and thus give the Federal Government a prior lien upon the assets of numbers of individual business concerns, on the basis of which Federal agencies may assume authority to determine managerial policies or compel their liquidation or consolidation. How far this process of extension of state capitalism may go, no one can say, but the monetary and financial powers for pushing it forward are available to the Administration, and the ideology upon which such an effort could be based—especially the necessity of extending the principle of "public interest" to all corporate enterprise, and the idea of centralization and integration of enterprise—is, of course, already complete and implicit in the Administration program, so that it becomes an important element in the background of the situation of industrial management; and in some fields, like the utilities and railroads and banks, a matter of immediate significance.

These lines of action indicated by the underlying theory upon which the Administration policy is based have been embodied implicitly in the structure of legislation passed by the last special session of the Congress. In the view of those who have been building it, this legislative structure is, of course, not yet quite complete. It will have to be rounded out by improvements in the control of the investment and security-market machinery, by further extension of governmental control over the banking system, by the development of a national transportation policy under Federal control, by extension of Federal authority over public utilities, and by Federal control over international trade and financial transactions. Furthermore, the detailed determination and administration of wages, working conditions, production, prices, profits, salaries, and of the relationship between economic groups as well as international business relationships will require an extensive Federal machinery of planning and control which is still to be constructed and which must have the power of securing complete statistical and other information regarding every aspect of economic activity from individuals and organizations as the basis for such planning and control. But the foundation stones for the structure of centralized governmental administration of the economic life of the entire nation have been laid in the legislation now on the statute books, and the purpose and direction of this control are already evident.

WHAT WILL BE THE CONSEQUENCES?

If this is the framework of popular psychology, official economic theory, legislative authority, and governmental machinery within which industrial management must operate, and if at the same time that management is the subject of this vast experiment in the reconstruction of our economic system its free functioning is so vital for recovery, it becomes most important to inquire in an equally realistic spirit whether there

is any early prospect that this background will be changed; and if not, what the consequences may be. Here one cannot rely only on objective observation of the attitude of the public and that of industrial management itself toward this new framework in which it now functions; one must depend also upon his own interpretation and forecast of the fundamental economic forces that are at work in the situation.

Let me, at the outset, sum up my personal answer to this question by saying that I interpret the present situation and all its implications as the most serious catastrophe that has occurred in our history and perhaps the most profound that has ever overtaken a great people. To me it marks the end of an unparalleled adventure in the organization of the free creative energies of a nation. I see in it the close of an era of expansion without precedent, the decline of the power and prestige of the United States as an exemplar of the creative force of free institutions. There will probably be a good measure of recovery, possibly a rapid speculative revival, under the influence of the inflationary forces that are implicit in the situation, but the background of the position of industrial management which I have described will not be materially altered and its old outlines restored within our time. The form and incidence of competitive forces will shift, but collectivistic tendencies will grow continuously, and the framework that has been set up will steadily strengthen and solidify until it is finally shattered by sheer force of more fundamental tendencies of economic and social decentralization and the outright revolt of a new creative generation still unborn. I do not believe that the tendencies which have found expression in the economic policies of the Administration and in the public attitude toward industry which underlies them are likely to be checked by any effective protest or opposition, for there is neither the necessary understanding nor the desire. They are fully accepted and supported by the American people.

It is impossible here to explain in detail the reasons for this view; I can only indicate briefly some of the factors involved and suggest some of their probable consequences for industrial management. Perhaps the most pervasive and fundamental factor is the stream of collectivist feeling which has flowed for fifteen years out of the creative frustration of the War and the spiritual sterility that has followed it, and which has found expression in all the forms of expansion of governmental authority over the individual—national socialism, state capitalism, communism, and fascism—which have overcome and perhaps permanently eclipsed the creative life of European countries. All these manifestations of authoritarian collectivism are expressions of the creative impotence of the individual, sublimations of the spiritual sterility of a people; but this is a disease of the age, an infection from which no nation is immune, a spiritual plague which is the penalty of a world war involving all nations. Even the United States, among the youngest and strongest of the nations, could not escape it. Its very youth and strength have made it a more ready victim of this epidemic, for we are among the most lawless and primitive of all peoples, and the more impulsively lawless a people is the stronger and more prompt is its unconscious, compensatory appeal to authoritarian principle and governmental power, as a measure of protection against itself. Wherever a group is subject to a profound sense of insecurity arising from poverty of resources, war exhaustion, or weakening of its biological creative powers, this sense of insecurity tends to express or compensate itself in mass violence, collectivist policies, and exercise of arbitrary governmental power. This accounts for a great variety of modern social symptoms, from Russian communism and Italian and German fascism to American mob lynchings and the Blue Eagle boycott of the N.R.A. The latter are only indications of the vast forces of mass emotion that have been set loose in this country by our political leaders and that will not be easily brought under control. This sort of spiritual disease will run its course, but that course may extend over centuries of a people's history.

REASONS FOR SUPPORT OF THE ADMINISTRATION'S PROGRAM BY MANAGEMENT

Of more special and immediate significance as a factor making for permanence of the collectivist framework of industrial management that has been erected by popular psychology and Administration policies is the attitude of industrial management itself toward it. Many have wondered why there have been no signs of concerted resistance of industry to the Administration's program of collectivist control. There is no mystery about this because that program has in fact the full support of the dominant interests in American business. It would not be altogether accurate to say that they are quite thoroughly collectivist in their thinking. The leading interests in American industry and finance undoubtedly do not really understand the collectivist implications of Administration policies or of public psychology or do not take them seriously; they rather imagine that they will run their course quickly as a passing political phase of party government; but their attitude toward the Administration program is directly or indirectly a powerful source of support for the collectivist movement, for several reasons:

In the first place, a group of important industrial and financial interests undoubtedly imagine that they can, by aligning themselves publicly with the Administration program, so to speak purchase immunity or secure a sort of protective coloration from attack in the pervasive storm of popular antagonism to industry and finance, and so gain advantage over other rival groups. In this sense there is, beneath the surface maneuvers of industry and finance in relation to the New Deal administration, an elaborate strategy of large-scale high-capitalistic conflict in the old style, in which New Deal ideas are used as window dressing for public or political favor or protection. There is something sardonic in this battle of the giants that is going on behind the façade of the New Deal, because the drama that is being unfolded now is not the traditional political puppet show, but is a Götterdämmerung, and in the end there will be no immunity for any group of industrial or financial interests. The only winner will be the Government in Washington, and the winner will take all.

Secondly, in every industry some interests imagine that they can secure permanent advantages over others in the industry by utilizing the code arrangements so as to freeze or rig the competitive situation in the industry in favor of themselves. The ways in which, in the construction and administration of codes, special interests in each industry are seeking to preserve the competitive status quo or to secure special protection are too many and varied to describe, but they explain quite simply the practically universal support which, for one special reason or another, industrial and business executives have given to the principle of Government control. There is a good deal of grumbling about this or that detail of codes or their administration, but nowhere a single question concerning the principle. It is erroneous to assume that American business or industrial management has ever been opposed in principle to Government control; it has always been in favor of control of the other fellow and of special protection for its own interest; and any system such as that set up under the Recovery Act, which promises to establish a practically universal machinery for protecting every industry, and every group within each industry, against every other, is favorably

regarded by each industrial interest involved and therefore by industrial management as a whole. The fact that this system only shifts the impact of competition to the weakest and least protected parts of the structure is not understood. Nor is there any realization that, from the original and ultimate point of view of Administration policy, this system is not established in the interest of employers or for the protection of profits, but in the interest of workers and farmers, and in the last analysis is to be administered solely to this end. Any special advantages that may accrue temporarily or accidentally to any particular interests are not likely to be permanently protected, as the scope and detail of governmental control are extended; but the hope of securing such advantages in each case encourages submission of management to such control and makes its universal extension and solidification easier.

Thirdly, in all these groups there are examples of the "tired conservatives" to whom I have referred earlier—industrial executives who have wearied of the struggle of protecting the vast vested interests, established by their own and others' youthful energies, against the stings of competitive insects bred by the shifting tides of economic change. Their management activities have become highly professionalized; the ownership interest is in many cases as numerous and shifting as the sands, diffused, impersonal, and remote. Their concerns have ceased to be enterprises in the original sense, and have become semi-public institutions, and they semi-official functionaries, or public servants. They yearn for peace and stability and welcome protection and security at any price, for their creative period is past.

Finally, perhaps the most important factor making for support of the Administration program by industrial management, and for its perpetuation and extension, is that most American business executives quite sincerely share the basic economic ideas underlying it. Of these ideas the two most significant which are embodied, or believed by industrial management to be embodied, directly in the Recovery Act are the consumer-king idea, or consumer-purchasing-power theory of prosperity and the principle of protection of profits or conservation of capital by control of competition through regulation of production and "stabilization" of prices. Parenthetically, it is doubtful whether the second idea actually is or ever was intended to be embodied in the Recovery Act, but industrial management almost universally believes it was, and that is the important point for present purposes.

It is not my intention, nor is there time, to analyze these ideas and explain why I believe they are both delusions and mutually contradictory. I have discussed them at length elsewhere and sought to show that general overproduction or underconsumption of goods and services is a myth; that, over a period of years, all goods and services produced are sold and consumed at some price; that consumption can be increased only by an increase in production and not by any arbitrary increase in wages, shortening of working hours, sharing of employment, or redistribution of money incomes; that, over a period of years, there can be no net real profit in business enterprise as a whole; that the process of dissipation of capital or savings is continuous in our modern economic system and fluctuates only with general changes in the value of money or the price level; and that attempts to regulate production, fix prices, and control competition so as to preserve or guarantee profits or prevent operation at a loss can only shift the incidence of the process of capital dissipation from one point to another in the business system, but can never stop it because it is as much a law of economic activity as the second law of thermodynamics is a law of physics.

But the important consideration for present purposes is that American industrial management almost universally believes that these things are not true. It shares with the public and the Administration a profound faith in the possibility of perpetual motion in the economic machine. It feels that by establishing control of the other fellow's prices, production, and wages, through an external arbitrary authority, it is possible to protect all capital investment from dissipation and enable all business to operate permanently at a profit. So long as these delusions prevail in industrial management and are encouraged by the Administration, it will progressively betray itself into the hands of an expanding Federal bureaucracy and cooperate unconsciously in the destruction of the capitalistic system and its replacement by a collectivist structure. For the essential element in the survival of that system is the safety valve provided by the chronic or periodic process of capital dissipation. When it is sought through any rigid guild system to supplant this process or prevent its operation by attempting to protect profits or wage rates, the system will first be transformed into a collectivist machinery for systematic formation and dissipation of capital under centralized authoritarian control, and finally will disintegrate into a decentralized and diffused economic order based on individual and local self-sufficiency and self-containment.

NO RETARDING INFLUENCES DISCERNIBLE

The latter is what I believe will ultimately transpire in the run, after a prolonged period of collectivist experimentation. Not only is industrial management, through its misunderstanding of the capitalistic system under which it has developed and its surrender to the Administration program contributing to this outcome, but I see nothing in the attitude of organized labor or of agriculture or banking interests or the public at large that will retard the movement through protest or opposition. There will be dissatisfaction with details and disappointment at the rate of progress among particular groups, but no real protest of the principle. The support of each group is being secured by promise of special favors; they are being rendered dependent upon the Federal Government for support or for special protection.

If they protest, as farmers and labor have recently, at some part of the program like the N.R.A., it will not be because they do not believe in it but because it is not being applied rapidly and drastically enough to serve their purposes. Labor wants industrial prices and profit controlled in order to raise the purchasing power of wages; the farmers are quite willing to have the purchasing power of urban wages raised if that of farm products is also raised by the same control of industrial prices and profits. Both groups are agreed upon the principle of expropriation of industrial profits. The farmers, in whom the instinct of property rights was supposed to be most deeply rooted and undoubtedly is so far as their own property is concerned, are thoroughly collectivist in their attitude toward railroads, utilities, banks, and industry, and will support any movement in that direction by urban workers, because they know that farms cannot be collectivized.

The great group of our population that is going to be ground to pieces in this process, the small shopkeepers, small manufacturers, and small investors in utility and other industrial securities—what we call the middle classes—is inarticulate and unorganized. This is the ultimate source of the pressure or resistance under which the collectivization process will explode. At first this revolt may temporarily take the form of extension of the authoritarian principle under some sort of fascist system—as in Germany and Italy—for self-protection of the middle classes; but I rather believe that ultimately in this country, because of the vast area and the abundance of

land and natural resources, it will resolve itself into a process of economic and political decentralization, a relapse into local political autonomy and economic self-containment, which is in accord with the fundamental economic forces that have been at work beneath the surface of all the political phenomena of the past twenty years.

THE ULTIMATE EFFECTS OF THE PROGRAM

The steps by which this may be the result of pursuing the general line of policy and underlying economic philosophy of the Administration to its logical conclusion are fairly evident.

In the first place, and most fundamentally, it must lead to a gradual lowering of the standard of living, or at least a greatly retarded rise in the standard of living. The economic welfare of any nation is dependent basically upon its output of work, the volume of goods and services or real wealth that it produces. We may shift debt burdens from one group to another and artificially redistribute wealth and income; but no nation can raise its standard of living merely by raising prices and wages through monetary manipulation or group agreement, or through curtailment of output and restriction of productive effort. The most important factor in the productive accomplishment of any people is the enterprise and effort of indivuals, as investors, speculators, inventors, organizers, and managers. The crippling of individual initiative and enterprise through the expanding control of bureaucratic agencies must inevitably lower the level of effective production, restrict opportunities for employment, and reduce the standard of living.

When this process comes into play, a powerful central government, supported by a widespread popular prejudice against industrial management and wealth, in which farmers and labor are joined in artificial fellowship, inevitably responds by extending the area and the detail of its control. As enterprise and employment decline or fail to expand freely, it is left with only one alternative. It must itself assume responsibility for industrial operations in a widening area. It must arbitrarily allocate employment and make an increasing investment of public funds in private enterprise in order to maintain employment and meet payroll requirements, which private enterprise and initiative are no longer able to do. This leads naturally to increasingly detailed dictation of industrial management and ultimately to government ownership and operation. Socialism and state capitalism have their roots in the destruction of individual enterprise and effort by bureaucratic dictation, and we can unmistakably see the beginning of this process in the position of the railroads, banks, and utilities in the United States today.

It was evident months ago, at the outset of the Administration's recovery program, that it would be compelled by the inevitable logic of events growing out of the forces of mass antagonism to industry which it recklessly let loose, to extend the area of control and make it constantly more detailed until it found itself forced to make large-scale investment in private enterprise and to dictate managerial policies in industry, business, and finance. The natural development of the inherent ideas in Administration policy has made it not merely a labor government, dominated by an organized-labor minority, and an agricultural government, dominated by the debtor classes on farms, but is rapidly carrying it to the stage of outright collectivism, dictated by all classes who have suffered by the depression and who imagine that the remedy for their distress is a deliberate expropriation of capital and redistribution of income. It is a sober fact that at the present moment the management of the productive industries of the United States has largely passed out of the hands of the executives of industry, and it is a practical certainty that the private ownership of industrial wealth will soon be called into question and modified by governmental action. This process will not stop with the destruction of managerial initiative in industry. It must inevitably extend, as it has abroad, to the control of labor organization itself. When government undertakes to manage industry, it must manage all factors. An economic system cannot operate part free and part controlled.

Finally, these processes, once set in motion, are inevitably accompanied by a progressive suspension of constitutional guarantees of individual liberty and safety and an invasion of personal rights of citizens. The right of privacy of business information is already suspended under the operation and administration of the Recovery Act. Detailed information regarding the operation of individual business concerns and regarding individual business and financial transactions is now required under compulsion by the central government. The freedom of the press and the right of individual public criticism of the Administration program have already been called into question.

Eventually, in so large a country, with such diverse sectional interests and such differences in economic conditions and in population, it is not impossible that any determined effort of a central government to enforce uniformity of conditions and exercise arbitrary authority over individual action may end in civil war and dissolution of the federal structure. By arraying farmers against urban workers, small businesses against large, small communities against big cities in an attempt to create an artificial uniformity or rectify inequities by central authority, the basis for virtual economic if not political secession is laid, for centralization is fundamentally opposed to the underlying tendency of economic forces today.

In the course of this process the peace and security which industrial management has expected from the recovery program will be long delayed and soon disappear. Its problems will be magnified and complicated beyond anything it has experienced in the past. The character and incidence of competition will be shifted, but on the whole it will be vastly intensified in every field by the injection of governmental forces. As prices are fixed and production controlled for protection of profits at the natural-resource or raw-material end of the industrial spectrum, the burden of the process of capital dissipation will gradually be shifted to the field of more elaborate fabrication and especially to the distributive field. With this shifting the process of technological disemployment will also be transferred to the distributive field and it will then face us in earnest as it never really has so far because the distributive and service occupations have heretofore been the great safety valve. We may even see a retardation of technological improvement in some fields of manufacture and raw material production, under Government encouragement, as we already do in agriculture under direct Federal regulation.

With the stabilization and increased artificial uniformity of raw material and manufacture prices and costs, transportation economies and advantages of location will become more important in marketing, and the exploitation of local markets by local products and the decentralization of manufacture will be stimulated. In the maintenance of national markets, with increased uniformity in costs and prices, the struggle will probably be concentrated on competitive advertising of trademarked products with appeal based on quality or service; but while the great centralized producers of nationally advertised products wear each other down and dissipate their capital in this process, locally manufactured and marketed products will make headway on the basis of lower advertising, marketing, and overhead costs.

Some of our old industrial elephants, accustomed to forage

(*Continued on page 62*)

MANAGEMENT *and* INDUSTRIAL RECOVERY

From the Report on Progress in Management[1] Prepared by the A.S.M.E. Management Division

THE CHANGE in attitude, the confidence, and the increased activity which have followed the settlement of the banking and currency crisis in the first three months of this year are definite evidence that the turning point of the depression has come and passed. What has brought about this turn after three years of sinking further and further into the business slough of despond? Heretofore, the change has come through some new circumstance, some new territory to open up, some new idea to exploit, some new product which catches the public enthusiasm, offering an opportunity for the investment of idle funds and for the realization of new profits. At the present time there exist no such frontiers to develop and incite the expansion of business from its subnormal levels. Yet we are the same people which a few years ago enjoyed an unbelievable prosperity. Is it not in the recognition of this fact, coupled with the overliquidation of our excesses which caused the depression, that we now turn of necessity for the first time to find that salvation lies at our own doorstep in the rehabilitation of that mass purchasing power which alone can maintain at normal levels the vast productive industrial capacity that this country has built up?

The old order changeth. Laissez-faire and rugged individualism have played their parts in the pioneering and development stages of our national growth. Unless we wish to continue muddling on and submit to whatever comes, willy nilly, we must create for ourselves a new state of affairs. Competition must give way in some degree to cooperation or else to a planned economy. No longer can the individual exploit the community for his sole gain. A new form of individualism based on social responsibility must transplant the old. Future prosperity will depend upon a fair opportunity for all. Profits will depend less upon special advantages and the differentials of opportunism and more upon the quality of service rendered the community and the well-being which it will bring about through respect for the rights of others. Unrestricted freedom of action will give way to regulation of business enterprise unless our leaders in commerce and industry willingly accept this new responsibility.

Accordingly, our President, through the National Recovery Administration, has flung this challenge to business management, demanding a new leadership in business. In no way should this "new deal" restrict business enterprise if handled correctly and if our business administrators recognize the justice of this new supreme authority. In principle it is merely the extension of the fundamentals of management to the upper strata of our economic life. The administrators of any enterprise have always set the objective for endeavor and defined the duties of their executives, leaving them to carry on their activities with a free hand accountable only for profits. In like manner the "new deal," through the N.R.A., is planned to set an objective for business and to hold its executives, the present administrators of business, responsible for the well-being and prosperity of the nation, leaving them supposedly free to act within the bounds of what is best for the community, cooperatively and not destructively. Thus, we can regain what has been lost and build more soundly an even greater mechanized economy for the future.

Management's opportunity is at hand. Its principles now must permeate every activity, no longer confined merely to the conduct of the affairs of each enterprise separately. We must all recognize the supreme authority of the community, the nation, and act accordingly. We must "play ball" to the last ounce of our capacity and energy. Only through teamwork, sportsmanship, integrity, and a true sense of responsibility, all of which are basic to management, can we achieve the leadership and morale which are essential to future business profits. Already management has responded to the challenge, and business executives, even those who have had less thought for the interests of others, are recognizing their social responsibilities.[2]

THE NATIONAL INDUSTRIAL RECOVERY ACT

In an effort to restore industry and trade, the Administration put through the National Industrial Recovery Act, by which unlimited power is given to the President to regulate industry and trade. The major objectives of the act are to restore employment, raise wages to a decent living standard, and build up purchasing power, in return for which, capital is granted immunity temporarily from hampering restrictions of the Sherman Anti-Trust Law, through the development of industrial regulation by the trade association. In so doing, however, the Administration failed to realize that, of the 3000 or so associations listed, only 50 to 75 were thoroughly organized and doing outstanding work. Code building, therefore, was lamentably slow, as only a few associations were prepared to develop satisfactory provisions, and seemingly irreconcilable disagreements among the members of other groups threatened the entire program. Only seven codes were put into effect within the first two months after the passing of the act.

To hasten action, the plan of the President's Reemployment Agreement was drawn up, whereby temporary individual codes would be accepted from each employer, who would be awarded the "blue eagle" upon signing the agreement. But trade and industry had no money to put into such a project without increased sales volume or higher prices at the source from which to foot the bill. A production jump and a retail-

[1] Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., December 4 to 8, 1933, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Abridged. The report was prepared by the following committee: F. E. Raymond, *chairman;* J. R. Shea, *vice-chairman;* W. H. Kushnick, *secretary;* J. A. Piacitelli, C. W. Lytle, and J. M. Carmody.

[2] There is omitted at this point brief comment on the Banking, Securities, Transportation, and Agricultural Acts passed by the Congress in 1933.

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sales spurt, to take advantage of the final stages of low manufacturing cost and low selling prices, lasted from June through August, when the consumer group began to react against price increases and cut down on purchases. Violations of the agreement became general, and consumers ceased to be interested and bought where they chose.

Meanwhile, the National Recovery Administration adopted the plan of setting up a maximum of between 300 and 400 separate codes, and of grouping related trades and industries under master codes. Where conditions in the various divisions of a group warranted, special supplemental codes were set up, in addition to the master code, to govern these divisions. These permanent codes will govern the industries until the National Recovery Act expires, or sooner if the emergency is declared over. These permanent codes, however, hold forth the greatest promise to industry. The adoption of codes, as Dr. Julius Klein points out, is by no means new, but the difficulties facing a trade or industry are not settled by such an action; they are merely beginning. There are many problems in the forefront for consideration, and their solutions will require years for working out. The change must be gradual, however, because the employer cannot raise wages appreciably until sales volume and dollar income keep pace with higher labor costs. For the present, profits will hardly be satisfactory—in itself a deterrent to increased activity—unless prices are unduly raised.

To prevent profiteering, some form of price fixing may have to be set up in connection with codes. Already sales below cost have been prohibited in the industrial codes established, and price setting has been included in the petroleum, lumber, and other similar codes. To restore employment, the Administration discouraged the installation of more machinery and of improved machinery and methods which would do away with the need for reemploying a greater number of workers. The efficient plant was thus penalized to the corresponding benefit of the inefficient shop. This, coming at the beginning of the recovery program, has been a severe blow to the capital-goods industries. A study of the situation revealed that employment was appallingly low in the capital-goods plants, whose business had fallen off as much as 60 to 80 per cent against an average of only about 20 per cent for factories making consumers' goods. A Machinery and Allied Products Institute was formed to handle the interests of equipment manufacturers, and succeeded in pointing out the need for removing the restrictions on improved machinery that had been put into certain codes. As a result, provisions are now allowed in industrial codes stating that obsolete equipment may be replaced by new equipment or by improved machinery, even though capacity limits may be placed on the industry in the effort to limit production.

Wage questions continue to form one of the main points of difficulty. The National Labor Board was established to deal with such problems. Similarly, through the United States Employment Service Act, it is intended to bring men and jobs together and thus correct one of the weak situations in economic readjustment due to the present local limits that exist in such efforts. A Federal Advisory Council is established to free employment from political influence.

PROBLEMS OF INDUSTRY UNDER THE NIRA

Irrespective of individual opinions regarding the merits of the National Industrial Recovery Act, its operation is positive and far reaching in its demands on managerial technique. Trade associations have been given a new status. In industries where they were weak or non-existent, they have been built up in order to participate effectively in the administration of codes required by law. Many managers have an entirely new point of view on competition and trade practises as a result of this participation in code development. These managers and many others will be required now not only to participate in the administration of codes, but also to reorganize their business practises to conform to code requirements as to fair practise, pricing of products, maximum hours of work in their plants, and minimum wages.

Many codes which were pushed through hastily under pressure will require revision. Managers who are alert to their jobs will have to become so well grounded in the operation of the codes which affect their particular industry that in the end they will contribute to the development of new industrial laws. It is here that progressive managers will find their largest opportunities during the years ahead. To the extent that they are able to help build a sound foundation against destructive forces within their industry, they will emerge as leaders.

Above all, managerial attention must be directed toward an entirely new problem—that of labor relations on a new basis. It is too early to predict what the ultimate result of Section 7-A will be, but the immediate effect is to extend the organization of labor into industries that have not been organized heretofore. The act compels collective bargaining where it is desired by employees. Managers who have heretofore had no experience in this field will be required to adjust themselves to this new situation, and the adjustment will come partly from practical experience and partly from a closer study of human and industrial relations in fields where this practise has existed.

The National Industrial Recovery Act very definitely increases the responsibility of industrial managers. They have always been responsible for the successful operation of their enterprises, but in the past they have been able to meet certain

situations by adjusting hours or wages. Under the new régime, neither of these constitutes an easy way out. From now on, other measures must be resorted to more in the nature of raising the quality of the product and of adjusting the cost of the product to the price range demanded by consumers. This suggests the complete elimination of waste and a more definite control of all costs, whether of direct labor or in the wide range of overhead which has not always been scrutinized as carefully as it must be in the future.

The American Federation of Labor has seized the present opportunity to strengthen the cause of organized labor. Its membership of 4,078,740, in 1920, had dropped to 2,532,261 in 1932. Of the 2,000,000 new members estimated as having been added to its rolls in 1933, by far the greater number came through new unions for which new charters have been granted. Some of these are federal or vertical unions—a new departure sponsored by Mr. Green to overcome the handicap in the craft-union system that results from technological development in industry. In spite of this fact, craft-union advocates still control American Federation of Labor policies.

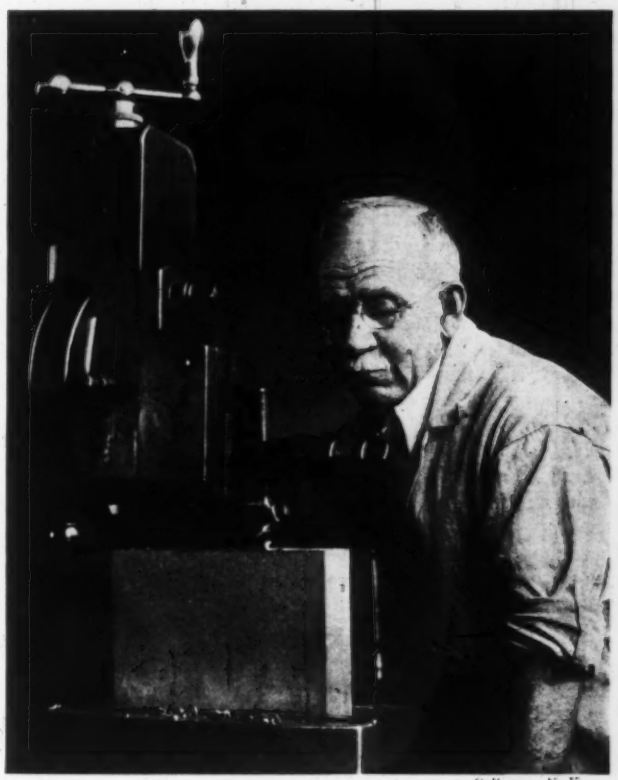
These developments are important to managers of industry because of the new demands to understand whom and what they are dealing with. It is true, of course, that many employees will remain outside trade unions altogether, and some will continue to be represented through company unions. Even here, recent experience has shown that managers must be more alert in negotiations. Members of company unions can change their allegiance more easily under the new order than they could before June, 1933. In some cases company unions have actually gone over in a body to standard unions. This suggests that managers who are dealing with company unions must put more realism and less sentimentalism into their dealings with their shop committees.

Even though some attacks have already been made on bonus systems, piecework, group insurance, and other incentive programs, it has been found on analysis that these criticisms are directed at abuses rather than against the principles involved. This points to the need for fairer and franker dealing with employees if these phases of scientific management are not to be publicly ridiculed and read out of our industrial practise.

Successful managers do not "chisel;" but this is not enough. If scientific management is to be developed and allowed to become a part of our industrial structure, its friends in industry must discourage piece-rate cutting and bonus abuses. Irritations that start in one plant are likely to spread more rapidly to other plants henceforth. Some price cutting and piece-rate cutting grew naturally out of the depression, but this condition cannot continue under collective bargaining, whether with standard or with company unions.

Standard costs take on a new importance under code administration. Many codes provide for selling above cost. But costs will be supervised by code authorities. This is a job for managers rather than for comptrollers. More than ever, managers must get into the fundamental operations that determine costs. The need for this is particularly important as industry faces rising prices for raw materials and rising wage rates.

It is not enough for managers to be good technicians. They very definitely face new problems, especially in the fields of labor relations, cost control, and trade practises. Herein lie new opportunities for seasoned managers to adjust their thinking along the new lines and for younger men who are coming on to prepare themselves in these essential fields. The colleges will begin soon to point some of their training in the direction of preparing young engineers to meet these new problems. In the meantime, engineering societies and management associations have begun to re-orient their programs and their discussions in this direction. Many men will learn, as they have in the past, by experience gained from first-hand dealing in the firing line. Success will be likely to come chiefly from an open-minded approach.



Galloway, N. Y.

DEVELOPMENTS IN MARKETING

During the past forty years, and intensively since 1911, American industry has adopted quite generally principles and mechanisms of "scientific management" which have become part and parcel of the factory executive's daily program. Meanwhile, a gradual revolution has taken place in the distribution of goods, stimulated by the obvious necessity of moving the products of mass production. However, only to a limited extent have techniques consistent with the application of science to production been introduced in order to effect "mass distribution" at costs consistent with the value therefor as represented in the consumer's price.

Deprivation in the face of ample supplies and excess capacity to produce have brought forcefully to the fore a realization of our inadequate knowledge and technique in marketing. It is evident that during the next few years we shall witness more intensified application of science in the field of marketing, consistent with that which has taken place in production during the last 20 years. The year 1933 has shown a marked change; even though it is barely a beginning, the trend is clearly defined.

Initial activities of the National Recovery Administration affect marketing in many respects. Regulation for fair competition in each industry represents concerted agreements as to prices and marketing practise. Merchandizing has been conducted recently on a basis of "price competition." With the elimination of price as a sales inducement, we shall have keen

competition on a basis of quality and service. If the public generally will pay the prices set or if each industry can suppress those who wish to profit by "illegal" price cutting, it now appears that this will benefit everybody affected.

There has been much talk and some N.R.A. action on "profitless selling" as an act contrary to public interest. Many retailers are no longer receptive to the idea of having a profitless item jammed through their stores by the sheer force of advertising. Mr. Dipman created something of a sensation at a recent meeting of the American Association of Advertising Agencies in Washington, when he declared that 45 per cent of the well-known trade-marked brands carried in grocery stores do not pay a sufficient profit to the dealer and thus are merely tolerated instead of receiving aggressive merchandising efforts.

Harry Leigh Irwin

Having excess facilities, many companies have undertaken the manufacture of new products. In some instances these products have been related to those previously made and thus are complementary in the line. Too often, however, they have been foreign to the manufacturing or marketing experience of the company, and in some such cases the venture has proved a costly failure. The intensified activity in adding new products of a related nature on the part of some manufacturers has forced competitors to follow suit.

The export market, completely demoralized during the last four years, showed little, if any, promise of revival during 1933. Some authorities believe that it has been permanently eliminated as an important outlet for American-made goods, except for patented products and a few items where our large domestic market permits us to produce faster and cheaper in spite of higher real wages. They reason that other nations have become mechanized in industry and on the farm and that most countries have now established import taxes to encourage and protect home industry. The fact is, the machine, as a factor in production, is now of world significance, and no longer can a single nation anticipate special privilege in international markets because of its former advantages through highly mechanized production alone.

EMPLOYMENT, WAGES, AND PURCHASING POWER

Unemployment, together with the severe liquidation in the earnings of all classes of people in this country and the attendant reduction in purchasing power, has been a most serious deterrent to any form of recovery. According to the unemployment figures of the Department of Labor, the maximum amount of unemployment was 13,360,000, and occurred in March, 1933. At the end of April, unemployment had decreased by 600,000 and was less than in January, giving hope that the recovery would be more rapid than was the decline. Stating the foregoing in positive terms, the Federal Labor Bureau index for employment was 55.1 in March, rising to 56 in April. Disregarding the supply of labor—that is, figuring the "shrinkage of employment"—the National Bureau of Economic Research found that in the spring of 1933 such shrinkage over 1929 amounted to approximately 8,000,000 jobs. The same authority is pessimistic regarding any prompt utilization of our full man-power.

While the average wage rates in all industries remained considerably above pre-war average rates, the average weekly earnings had declined below those of 1926 on account of shortened hours, and real wages declined more rapidly than the cost of living. The National Industrial Conference Board reported average weekly earnings for 21 major industries as $14.42 for May and $15.83 for June. The low wage rates may be illustrated by citing the rate of common labor in road building—16 cents an hour for East, South, and Central States, and 48 cents in Pacific States. The manufacturing industries varied from 22 cents an hour in the cotton-goods industry to 76 cents in newspaper printing. The variation in entrance rates was still greater, indicating that some companies had taken considerable advantage of the labor distress. Certainly, large numbers of unskilled laborers received less than a respectable living wage during this bottom period of the depression.

The first few weeks after the national election, business seemed to mark time on account of the banking situation. The happy outcome of that situation cleared the way for renewed confidence, and in May better employment conditions began to develop. The cotton industry was the first to show this confidence, employees expressing willingness to reduce their time to 40 hours per week. About the same time Gerard Swope advocated a 30-hour week for the electrical manufacturing industry. Also, President Roosevelt made it clear that he considered it time to end any further reduction of wages and that he believed it essential to advance wages as high as possible. It was estimated that at least 100,000 employees received wage rises during the month of May. In June the automobile industry increased rates mostly 5 and 10 per cent, and the New England textile industry went on a 40-hour week with 1929 wage scales. As a result of the automobile situation, the iron and steel industries increased employment 9.8 per cent in June as compared with May, and payrolls 22 per cent as compared with May. The railroads, which for some time had been planning a further reduction of 25 per cent in wages, then postponed any cut for eight months.

In the meantime the National Industrial Recovery Act began to take shape, and 130 trade groups offered their cooperation. This was a period of feverish activity as far as planning was concerned, and probably the fastest upheaval in the thinking of employers which has ever occurred. Almost all industries cheerfully increased wages and reduced hours in compliance with the provisions of the recovery act. This resulted in the greatest rise in both employment and payroll

figures that has ever occurred for the same season of year. A month before its code was in operation, the steel industry raised wages 15 per cent. Some companies not only raised their lowest rates to meet minimum requirements, but raised all rates to retain their carefully adjusted differentials. This was done on a percentage basis in most cases, but also in a flat amount of money per hour in other cases.

Gains for July as compared with June amounted to 7.2 per cent for employment and 7.9 per cent for payroll. Furthermore, the gain in man-hours between the same periods was 14.1 per cent, and the increase in purchasing power was estimated at 13.9 per cent (N.I.C.B.).

INDUSTRIAL RELATIONS

The confusion of making codes which could be agreed upon by both employer and employee continued through the summer and fall. Strikes increased in certain industries, involving 300,000 employees at one time or another during August. Differences which were settled either by voluntary compromise or by governmental persuasion failed to stay settled. Old questions such as the open shop versus the closed shop, the labor union versus the company union, the craft union versus the vertical union, the liability of discharge, etc., came out again in full vigor.

Recognizing the need for quick action on all questions of industrial relations, the Federal Government set up temporary boards to arbitrate between labor and capital, and a unified board similar to the War Labor Board was brought into being by August 6.

Although the business index for the whole country fell back during the late summer and fall, the employment and payroll figures continued to rise through August and September, at which time it was estimated that 4,000,000 persons had found employment under the recovery program. Another 4,000,000 are scheduled to be employed by the end of the year.

One of the definite gains from the code program is what seems to be the elimination of child labor. The cotton code set a minimum age of 16 years for that industry; other major industries followed the lead; and various state legislatures took steps to make the gain permanent.

At the same time the sweat shops were brought into the open and investigated. Many isolated cases of starvation wage were uncovered. Some of these were on a large scale—as, for instance, workers in New York State shirt factories to the extent of 180,000 averaged $7 a week, those in rural districts earning less than that. It is thought that the minimum-wage feature of the codes will greatly lessen this abuse.

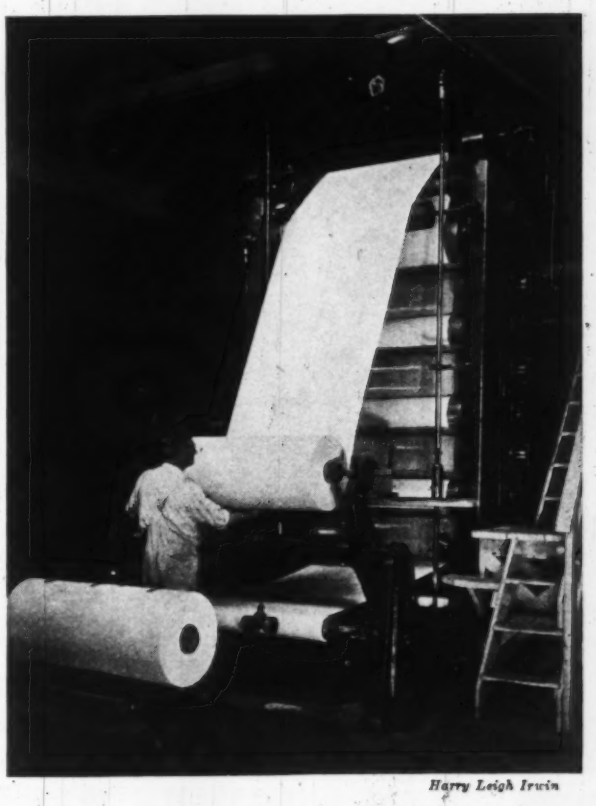
Due to the influence of the codes and also to the rise in cost of living, the movement for minimum-wage laws has extended rapidly. No less than 14 states had either passed laws or changed former laws by the middle of August. These laws are of particular benefit to unskilled labor and women. In New York State alone the new law will affect 125,000 women.

Voluntary benefit plans for unemployment have been much discussed, but little adopted. Those previously in effect, such as the Dennison plan, the Procter & Gamble plan, the General Electric plan, the Rochester plan, etc., are being observed, but employers in general seem reluctant to follow these leaders.

However, agitation for the establishment of unemployment insurance by state enactment has increased. More than 100 bills on this subject have been offered in the recent legislative sessions of 29 states. At the time of writing, only one state, Wisconsin, has passed such a law (1931) to become effective July 1, 1934. Commissions to study the subject are, however, at work in 12 states. Of these, seven have reported—six in favor of the measure and one against it. The other commissions are expected to report presently.

A United States Employment Service has been revived, to work on a 50–50 basis with state bureaus, and is particularly aimed to recruit deserving employees for public works. This board carries on without any political patronage, and by working through local groups its placement will not involve any distant transportation.

Figures on safety may seem meaningless because of the low employment, and yet the continued decline of industrial accidents in terms of rates does mean progress. Using 1926 as 100 per cent, the frequency rate for "all industries" in the United States was down to 38.5 per cent and the severity rate was down to 64.7 per cent. This is an excellent showing so far as frequency goes, but it is also evidence that severity is not being controlled nearly so well. For 1933 only partial figures are available at the time of writing. The industrial commissions of 13 states received reports during the first four months from which it appears that occupational accidents have been reduced 21 per cent relative to the same period of 1932. This is largely due to low employment. Management must not neglect safety during the reemployment period.



Harry Leigh Irwin

JOB STANDARDIZATION

Since the codes are enforcing increased labor costs on existing jobs, there is sure to be a more intensive use of "time and motion study"—that is, job standardization, to improve work methods. Savings of this kind have been great for years, but the surface has barely been scratched. The "compromise procedure" of using micromotion principles, together with "stop-watch" technique, is the new way of deriving better methods, and it is becoming very popular.

Although not entirely ignored in the past, greater attention is now being given to the set-up time in job-order shops. The trend of thought today, even in mass-production plants, is flexibility of equipment in order to avoid the great expense of obsolescence of single-pur-

pose machines. However, the experience derived from quick set-up features of single-purpose machines is being applied to adaptations of standard machines. Rapid traverse attachments, adaptations of drill heads and milling heads, and the use of flexible jigs all contribute greatly to the reduction of set-up time without the need of special or single-purpose machines, thus saving time and avoiding the risk of obsolescence in case of radical changes in the product.

WAGE INCENTIVES

Although American industry has come to use day guarantees with piece rate and with other incentive plans to a large extent, there yet remains enough straight piece rate to make the outlawing of that and other "payment by results" plans for low efficiency seem strange indeed. The use of such earning plans under certain conditions has been and will always be desirable. The prohibition of them in a country where competition is keen can result only in one thing—a closer scrutiny of the production records of all doubtful producers and consequent weeding out of many who had formerly been tolerated at low but earned wages. In this development there is also another objection to union interference with discharge, and unless the unions cooperate better than ever before toward raising the efficiency of workers in the lower brackets, there will be some difficulties. During the downward phase of the depression there was a tendency to reduce the amount of the bonus at high task so that the more efficient employees would sacrifice somewhat to those less efficient. Now, in the upward phase, the tendency is the opposite—that is, to make incentives for increasing efficiency more favorable than ever. Furthermore, it has been suggested that profit sharing be used on a wide scale with the purpose of making wages vary with prosperity. The usual feeling that the owner takes all the risk and therefore deserves all the profit is giving way to the feeling that workers take a considerable part of this risk also and that unless they share in the profit they cannot buy in proportion to the rate of production. The difficulty lies not in the unwillingness of American employers to share prosperity profits, but in the complexity of the problem. So far, profit sharing, stock ownership, and sliding scales for employees have not proved uniformly successful. There appears to be an era of revolutionary experiment ahead of us.

EQUIPMENT, PLANT LAYOUT, AND MAINTENANCE

In view of the problems of recovery arising from the present severe competition and unemployment situation, the burden imposed upon industry by its available plant capacity with its excess productive equipment is assuming markedly increased importance. The N.R.A. has been given the power to restrict the purchase of new equipment in any instance where an industry is overequipped. This will enforce hardships, not only upon the producer, but particularly upon his equipment manufacturer. Under such conditions, unless recovery shows a rapid upswing in the near future, the equipment manufacturer is faced with a continuing low level of activity. He stands to benefit chiefly through modernization programs in the plants of his customers now permitted by recent N.R.A. rulings or by offering equipment which can effect savings not so much in labor hours as in the indirect cost of manufacture. In line with all this, the equipment industries serving the various branches of American business have demonstrated their faith in the future by carrying on very extensive development work during this depression, as they did in depressions of the past, with the result that there have been decided improvements in equipment which make possible large decreases in the cost of production.

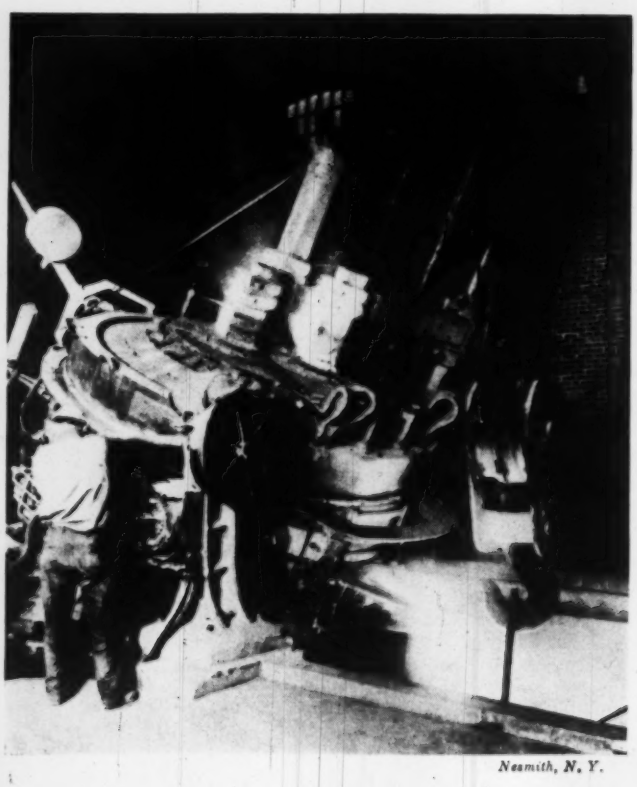
It is very evident that changes in the designs of old products and the development of new products effected during the last three years will tend to accelerate the demand for new manufacturing equipment. A more liberal optimistic spirit on the part of management who are in control of capital expenditures is required at this time in order to meet the coming upturn in business in the most constructive way and also to avoid an excessive demand for new equipment when business once returns to a normal level.

One hopeful sign is that the exigencies of the last few years have forced manufacturers to give more constructive thought to the proper replacement of obsolete and worn-out equipment on a truly economic basis.

As one solution to the problem of increased manufacturing cost due to subnormal levels of operation, manufacturers are scrutinizing more carefully their plant layouts in an effort to reduce that overhead which comes from the manner of processing their products through the plant.

Maintenance countrol as a source of economy in manufacture received accelerating recognition as the depression continued. The higher cost of manufacture, inherent in operation under the National Industrial Recovery Act, is rapidly consolidating this position. More than ever, maintenance is recognized as embodying the responsibility for the prevention, in preference to the correction, of failure.

Similarly, the shift in emphasis from direct labor costs to those of a more indirect nature as found in factory overhead has had its influence upon production and material control and an increased interest in the elimination of waste. In the control of production and materials there is an increased tendency toward simplicity. In several cases the number of records has been reduced while in others an eye is kept on all orders by the aid of a visual card-index system.



Nasmith, N. Y.

THE A.S.M.E. ANNUAL MEETING

Far-Reaching and Constructive Programs for the Society and the Engineering Profession Predominate

AT THE end of the epoch of industrial expansion and national economic prosperity that followed the World War, The American Society of Mechanical Engineers celebrated, in 1930, its Fiftieth Anniversary. The significance of the stock-market debacle of the preceding November had not been thoroughly grasped, "new era" optimism was still in the ascendency, and it was hard to believe that economic life in this most progressive of all nations could ever suffer such serious setbacks as the subsequent years brought upon it. The warm feeling of satisfaction in a job well done for their fellow men—the providing of material abundance, cheap widely distributed power and its blessings, and quick and effective means of transportation and communication—justifiably pervaded the thoughts of the commentators at the celebration gatherings and suffused their minds as they sought a perspective with which to view their past accomplishments and their future conquests. High hope and valorous determination were expressed in the anniversary-medal inscription, which became the keynote of the time, "What is not yet, may be."

PAUL DOTY, PRESIDENT, 1934
The American Society of Mechanical Engineers.

The four years that have passed since the planning and execution of that great anniversary have been filled with bitterness; the haunting apprehension of worse things to come in the minds of those who experienced the least severe consequences of the economic shock, and the stark reality of blasted hopes and thwarted careers by those who felt its full force. A "new deal" has been substituted for a "new era," and once more men turn hopefully toward the prospect of better times.

The engineering profession, individually and collectively in national societies, has suffered seriously by the events and catastrophies that have crowded the years since 1929. A critical scrutiny of one phase after another of society and professional affairs, sometimes carried on rationally and at other times hysterically, has brought into question many procedures, traditions, objectives, and activities that a more prosperous age had known and accepted. It has been the temper of the times to be suspicious of existing orders and organizations, to imagine that prosperity brings more of decadence than of progress into our lives, and that it blinds us to ideals, motives, and objectives which need restatement in hard times. As in the lives of individuals, so in the profession of engineering and in the national societies ministering to it drastic reductions in income have called for curtailment of activities and the withdrawal of support where previously it had been given ungrudgingly and most generously.

During these years there were times when the elements of disintegration and economic attrition threatened the confidence and morale of engineering organizations as viewed by those who saw only a reduction in activities and fewer tangible dividends of professional cooperation and copartnership in society and professional affairs. But fortunately these destructive forces have as yet not prevailed, and the evidence seems to be at hand that their influence is being replaced by constructive forces that have survived and grown in strength. Such evidence is to be found in the recent Annual Meeting of The American Society of Mechanical Engineers, New York, N. Y., Dec. 4–8, 1933, at which these constructive forces could be seen at work, already bearing fruit.

To an observer who has been close to the critical years of the Society's and the profession's history, this year's meeting seemed to have an atmosphere of confidence, determination, and courage that the constructive forces which had been persistently although quietly at work, engendered. It seemed as though the spirit of confused purposes that resulted from the shock of economic disaster had been replaced by a courageous conviction that the way to advance is to attack, and that definite objectives toward which advance could be commenced had been determined. This undercurrent of constructive forward-looking action has been swelling with increasing strength throughout the past few years and now becomes, so it seems to one observer at least, the dominant one that determines the direction of flow. From now on, unless these signs are deceptive, progress seems assured and objectives agreed upon. The forces of recovering are at work.

What, then, is the basis for such belief in the future? In spite of the fact that the Annual Meeting provided an unusually profitable technical program, it must be admitted that the meetings on Monday afforded the most encouraging signs of strengthened morale and determination to proceed constructively toward worthwhile objectives. Viewed in the light of

recent years, Monday was unique. On it no technical sessions were scheduled, so that the entire day was set apart for affairs relating to the Society and to the welfare and advancement of the profession.

A meeting of the A.S.M.E. Council in the morning was attended by administrative and technical committeemen, representatives of the Society's local sections, and members of the Society. The agenda were so numerous that when a recess was taken at noon for luncheon, only a few reports had been presented. The largely attended business meeting occupied most of the afternoon, and, following a dinner of the Council, the adjourned morning session reassembled in the evening to take up the remaining agenda, and these were not completed until eleven o'clock.

The purpose of the public meeting of Council was to afford the fullest opportunity to present and discuss the reports of the committees under whose direction the Society's activities are carried forward. The reports, preprinted and distributed in advance of the meeting, were presented in a manner which called attention to their important sections. Discussion and criticism were freely indulged in and points that had not been brought out were made clear as a result. The impression was gained that the committees had rendered commendable reports of faithful stewardship under vexing economic conditions, and that they were receptive to suggestions and criticisms coming from those having different points of view. In this connection may be mentioned particularly the pains with which the Committee on Finance answered in detail the queries of members and representatives of the Local Sections and the subsequent meeting with the latter group to provide additional information, and the warmth with which several technical committeemen urged upon Council a more favorable consideration, from the point of view of money budgeted, of their useful activities which have always brought enviable professional prestige to the Society. All in all, there was a wholesome straightforwardness in the discussion, comments, criticisms, and explanations that did much to clear the air and reassure the average member that his affairs are in the hands of competent committeemen whose principal shortcomings are the all too human weakness of being misunderstood and the enforced inaction that comes from economic necessity. Had a vote of confidence in the Council and its committees been taken among non-committeemen present, it would undoubtedly have been passed with an overwhelming majority.

The second feature of Monday's program which inspires confidence in the future and makes the day stand out in the minds of many observers as a high point in the history of the Society and the profession was the business meeting. Those who have witnessed the mere handful of members who usually come together for the perfunctory business to be dispensed with at this time would be amazed at the size of this year's audience and the constructive character of the program. Three features stand out so prominently that they should become, if possible, a part of every annual business meeting. First, the meeting was held at a time and under conditions that guaranteed a maximum attendance, there being no "competing" events. Second, the program was constructive, non-technical, but broad enough to be significant to the profession as well as to the Society; it looked toward the future, and it was ably presented. Third, under "new business" the gathering evolved into a spirited "town meeting," at which any person so desiring could unburden himself of whatever was on his mind, a spontaneous and unscheduled loosing of comments, suggestions, and criticisms from which profit might come to those who spoke and those who listened. It was a well-spent afternoon. It gave ample evidence of the fact that throughout the depression constructive forces have been at work within the Society which are destined to have a far-reaching effect on its history and that of the profession. Particularly to be mentioned in this connection are the reports of the committee of representatives of the Founder Societies looking toward a coordination of their joint interests and activities, of the Engineers' Council of Professional Development, of the Committee on Policies and Budget, and of the newly formed Committee on the Capital-Goods Industries.

A third source of encouragement and satisfaction that may be looked upon as having significance lies in the excellence of the technical program, which embraced several symposia on broad and important topics and in the registration figures. In spite of the fact that employment among engineers is probably at its low ebb, and that financial hardships are being borne by all, the registration of the 1933 meeting was 1970, slightly below last year's. When it is considered that the registration of the women guests was below last year's, it will be admitted that interest in the Society's technical and professional program was real and sincere. To present, in the fourth winter of the depression, a technical program of 119 papers and reports, as compared with 90 in 1928, to a group of so many engineers is an achievement that speaks volumes for the faith and loyalty of the profession. It cannot be ignored by those who seek signs of recovery or by those who believe in the firm foundations upon which the A.S.M.E. and the engineering profession are based.

THE OPEN MEETING OF A.S.M.E. COUNCIL

We come now to the events of the historic Monday meeting which was opened by an address by President Potter in the form of a report to Council, delegates, and Division and committee representatives.

After his opening felicitations, President Potter presented the seven delegates who were selected at the regional meetings of the sections' delegates in October to represent the seven groups of the Local Sections. These delegates were:

Group I. George E. Hulse, Chief Engineer, Safety Car Heating & Lighting Co., New Haven, Conn.
Group II. George B. Pegram, Professor of Physics, Columbia University, New York, N.Y.
Group III. B. F. Rogers, Production Superintendent, Luzerne County Gas & Elec. Corp., Kingston, Pa.
Group IV. Blake R. VanLeer, Dean, College of Engineering, University of Florida, Gainesville, Fla.
Group V. B. M. Brigman, Dean, Speed Scientific School, University of Louisville, Louisville, Ky.
Group VI. E. H. Sager, Washington University, St. Louis, Mo.
Group VII. Fairman B. Lee, Seattle, Wash.

President Potter then thanked the various officers, committeemen, and the Secretary and his staff for services rendered during his administration. On the subject of finances he said:

Last October there was mailed to each one of you the Report of Council for 1932–1933, the Preliminary Statement of the Finance Committee, and the reports of technical and general committees. The expenditures for the year ending September 30, 1933, were $200,000 less than for the preceding year and the budget approved by Council for the year beginning October 1, 1933, involves a further reduction of nearly $100,000. This great reduction in the budget has meant drastic curtailments in all of your Society activities. At the same time, every effort is being made to encourage the Local Sections, to maintain technical leadership through the Professional Divisions, to protect the activities of the technical committees, and to maintain the effectiveness of the standing and special general committees.

He then briefly surveyed the major problems undertaken by Council during his administration, as follows:

(1) The Special Committee on Policies and Budget, under the effective chairmanship of Harry L. Westcott, has analyzed past accomplishments, aims, and objectives of your Society. The work of this committee will prove helpful to you in shaping the future policy of the Society in the years to come. The A.S.M.E. is the result of the best and most unselfish thoughts on the part of the founders and older members of your Society. Many of their objectives conceived fifty years ago are the guiding posts of today. However, changes in social, economic, and political matters during recent years bring about a need for redefining the purposes and for erecting new guides for the future. The Committee on Policies and Budget is at work securing material for your use in shaping the future destinies of your Society.

(2) Your Council has initiated a program intended to stimulate the durable- or capital-goods industries. These capital-goods industries represent transportation, construction, and machine-making. They are not only the most depressed of all industries, but employ two-thirds of the industrial labor of this country and have a major effect upon national recovery and upon the well-being of engineers.

(3) Your Council has approved the Code of Fair Competition for the Professional Engineering Division of the Construction Industry, which approval carries with it a responsibility for your Society to participate in the Board of Control which will administer the provisions of the Code.

(4) Your Society is participating actively in the Engineers' Council for Professional Development, which has as its major objectives better preparation and greater prestige for the engineer.

(5) During the past year your Council approved the model law for the registration of professional engineers and surveyors.

(6) Your Society has been active in unemployment relief, and it is the belief of those directly concerned with this problem that the individual engineer must acquire greater skill in creating and in finding new employment.

(7) Your Society is cooperating actively in a program for unifying the engineering profession.

(8) Your Council has authorized the appointment of a special committee on Junior Participation, as it recognizes the increasing importance of Junior members to the Society.

In closing he said:

Your president, during his term of office, has visited over one-half of the Local Sections, over one-third of the Student Branches, and three Student Regional Conferences of your Society. He attended personally every one of the nine regular meetings of your Executive Committee and wrote hundreds of personal letters to individual members of your Society, in addition to numerous official communications. His contacts with thousands of individual members and with sections of your Society in different parts of the country strengthen his enthusiasm for the quality of the A.S.M.E. members and his conviction that your Society is in a strong position professionally to render constantly increasing service.

Your president is absolutely convinced that the A.S.M.E. has no cliques or factions, that it is not being dominated by a New York coterie or any other group, and that with your help and encouragement the Society can maintain at a high level its services to its members, to the engineering profession, and to the public.

My association with the members, officers, and committees has been a source of pleasure for me. I greatly appreciate the encouragement which I received from every one of you during my term of office, I bespeak your cooperation for the new officers, and I hope that you will continue to devote your best thoughts to the problems which are facing your Society during the present most difficult period.

A.S.M.E. TRANSACTIONS TO BE ISSUED MONTHLY

At a meeting of the Council of The American Society of Mechanical Engineers held on December 8, 1933, a new plan for the printing and distribution of the Transactions, proposed by the Committee on Publications, was approved. Briefly, effective January 1, 1934, the Transactions, including Aeronautical Engineering, Applied Mechanics, and the Record and Index, will be issued monthly and distributed to every member in good standing registered in the Society's Professional Divisions and to every member in good standing, not so registered, who requests it. Under this plan, every member may receive every issue of the Transactions, which will contain all the papers issued by the Society in this publication. "Mechanical Engineering" will be continued as at present.

The new plan requires no action on the part of members who are registered in one of the Divisions and are now receiving any section of the Transactions. Any other member in good standing who is not registered in one of the Divisions and who would like to receive Transactions monthly should ask to have his name placed on the mailing list. Address requests to The Secretary, A.S.M.E., 29 West 39th Street, New York, N. Y.

ACTIONS TAKEN BY EXECUTIVE COMMITTEE

The report of the actions taken by the Executive Committee of Council on December 3 were reported by the executive secretary. Important actions were as follows:

The Executive Committee voted that during the period of cooperation with members to hold them in good standing with temporary suspension of dues in part or whole, for those members who become 35 years of age and who cannot afford the transfer charge for change of grade which is mandatory, this transfer charge be held in suspension but that the transfer charge must be paid before or at the time of the discontinuance of the temporary suspension rule covering dues, if the member is to remain in good standing.

The Executive Committee voted to utilize the services of the auditor in checking up the figure of dues receivable as a means of collecting dues owing to the Society and establishing the fact that the members recognized an obligation to the Society. Following this, the cooperation of the Local Sections is to be asked in establishing the ability of the individual to pay the dues, and, thereafter, delinquents will be dropped.

The Executive Committee approved the recommendations of E.C.P.D.:

(1) That the E.C.P.D. be authorized to undertake a program of accrediting the curricula of the various schools of engineering which are deserving of approval as representing sound instruction in various fields of engineering (the accrediting agency to be self-supporting).

(2) That the President be empowered to appoint two members of the Council and the chairman of the Membership Committee to meet with the E.C.P.D., study the recommendations of the E.C.P.D. with respect to the minimum definition of an engineer and uniform grades of membership in the engineering societies, and report back to Council.

The Executive Committee authorized the President to appoint a Committee on Gifts and Endowments, as recommended by the Special Committee on Policies and Budgets, to encourage legacies, gifts, and endowments for the purposes of furthering the work of the Society.

REPORT OF FINANCE COMMITTEE

The report of the Committee on Finance was presented by the chairman, K. L. Martin. [The reports of this and other committees of the Society were preprinted and circulated prior to the meeting, hence they were only briefly abstracted. The

complete reports will be published in the *Record and Index*.] Mr. Martin referred to financial difficulties on account of great falling off in advertising income and dues paid, and to the heavy write-off in doubtful assets. In a discussion of the report it was brought out that certain local sections had requested additional information and other breakdowns of expense items. Mr. Martin arranged a conference with the Local Sections, Delegates at which these items were supplied. Resolutions from the Group Conferences of Sections' Delegates relating to initiation fees, dues, allotments to sections, and the form of financial reports were referred to Council for consideration at some later date.

PUBLICATIONS

L. C. Morrow, chairman of the Committee on Publications, presented the report of that committee. The chief interest centered in a recommendation, not included in the annual report, that the *Transactions*, including *Aeronatuical Engineering*, *Applied Mechanics*, and the *Record and Index*, be issued monthly and distributed to every member registered in any Professional Division and to any other member, not so registered, who should request it. The recommendation was referred for discussion to the joint consideration of the Committees on Meetings and Program, Professional Divisions, and Publications, and to the Sections' Delegates. These groups approved the plan in principle and the plan was formally presented to the Council at its meeting on Friday morning where the necessary actions were taken to permit the Committee on Publications to put it into effect January 1, 1934.

Recommendations relating to publications proposed by the Group Conferences of Local Sections' Delegates were referred to the Committee on Publications. Mr. Morrow also reported that, in accordance with the vote of Council at Chicago in June, *The Engineering Index* would suspend operations January 1, 1934, unless some means of financing could be arranged by that time. Mr. Morrow intimated that the committee was not without hope that support would be forthcoming.

LOCAL SECTIONS

Reporting for the Committee on Local Sections, James M. Todd, chairman, presented the high points of the year's activities. Amendments to Article B-11 of the By-Laws relating to an Annual Conference of Delegates of Local Sections, was accorded its second reading and was favorably voted upon. The amendment reads:

An Annual Conference of Delegates of Local Sections shall be held in connection with the Annual Meeting of the Society. Representation shall be as specified in the Rules.

The sense of the meeting was expressed, in a motion, as favoring a renewal of the group-conference plan in 1934.

Other recommendations from the Group Conferences were presented by Dean Brigman and referred to the committees involved.

AMERICAN ENGINEERING COUNCIL

The important question of the American Engineering Council was next in order of discussion. An amendment to Article B-8 of the By-Laws was given its second reading. Approval was voted. The amendment reads:

The Council shall appoint delegates to serve on the American Engineering Council as required in the By-Laws of that body. If the number of delegates required to serve is at variance with the number elected or in office, the Council of the Society is empowered to make adjustments necessary.

D. Robert Yarnall then reviewed the report of the A.S.M.E. delegation on the American Engineering Council, discussing in detail the financial problems of that Council. Mr. Batt spoke convincingly of the value to the engineering profession of the American Engineering Council, and Dean Brigman, for the Group Conferences, offered a resolution that was enthusiastically passed, that the A.S.M.E. continue "to support the idea of the American Engineering Council."

STUDENT BRANCHES

When the Council reconvened on Monday evening, Roy V. Wright presented the report of the Committee on Relations With Colleges in which he spoke enthusiastically of the new plan which has now been installed in 82 student branches with an enrolled student-branch membership of 1368.

For the Committee on Meetings and Program, the chairman, J. W. Parker, presented a report of the year's work, commenting on the problem of selecting presiding officers, preprints of papers, finances, and the possibility of the committee's extending its activities to assist the Sections in the conduct of meetings.

Dean Brigman reported further resolutions from the Group Conferences, relating to the continuance of the Mid-West office and an appreciation of the services rendered by Ernest Hartford, assistant secretary, to the Local Sections. The resolutions urged a speeding of the work of the Engineers' Council for Professional Development, and recommended that "resignations be requested of engineers whose conduct renders them unfit to remain members of the Society." The resolutions were referred to the agencies concerned with them.

JUNIOR PARTICIPATION

While this meeting of Council was in progress, a group of junior members of the Society was conducting a meeting devoted to their interests and problems in an adjoining room. It will be recalled that Council had set up a Committee on Junior Participation which was to report to the 1933 Annual Meeting. R. F. Gagg, chairman of that committee, presented this report which, it is hoped, will be printed in a subsequent issue of MECHANICAL ENGINEERING. The report discusses the objectives of the young engineer in joining the A.S.M.E., his introductory contacts with the Society, and his professional development and training. It suggests the establishment of a "Junior Forum;" the active participation of junior members in the work of the Society; the award of one or two certificates of honorable mention to juniors in addition to the now-established Junior Award of fifty dollars and a certificate; more active participation in meetings; and provision of opportunities for service on technical committees and on the administrative committees of the Society.

It was pointed out that Mr. Gagg himself has served brilliantly and usefully as a junior member of the Committee on Meetings and Program, and it was suggested that he provide a list of junior members who would be willing and competent for similar service on Society committees.

CODE OF ETHICS

Amendment to article B15, Par. 1—Code of Ethics, was read and upon motion adopted. The amendment reads:

All members of the Society shall subscribe to the following Code of Ethics, as required by the Constitution:

A CODE OF ETHICS FOR ENGINEERS

That the dignity of his chosen profession may be maintained, it is the duty of every engineer

(1) To carry on his professional work in a spirit of fairness to em-

ployees and contractors, fidelity to clients and employers, and devotion to high ideals of personal honor.

(2) To refrain from associating himself with, or allowing the use of his name by, any enterprise of questionable character.

(3) To treat as confidential his knowledge of the business affairs or technical processes of clients or employers when their interests require secrecy.

(4) To inform a client or employer of any business connections, interests, or affiliations which might influence his judgment or impair the disinterested quality of his services.

(5) To accept financial or other compensation for a particular service from one source only, except with the full knowledge and consent of all interested parties.

(6) To advertise only in a dignified manner, to refrain from using any improper or questionable methods of soliciting professional work, and to decline to pay or to accept commissions for work secured by such improper or questionable methods.

(7) To refrain from using unfair means to win professional advancement and to avoid unfairly injuring another engineer's chances to secure and hold employment.

(8) To cooperate in building up the Engineering Profession by the interchange of general information and experience with his fellow engineers and with students of engineering and also by contributions to the work of engineering societies, schools of applied science, and the technical press.

(9) To interest himself in the public welfare and to be ready to apply his special knowledge, skill and training in the public behalf for the use and benefit of mankind.

Amendment to Article B-5, Par. 9, of the By-Laws, relating to life membership, was adopted on motion. This amendment reads:

A member may become a life member by paying the Society at one time the present worth of an annuity due equal to that member's dues for the period for which he is required to pay dues in accordance with the Constitution, By-Laws, and Rules.

TECHNICAL COMMITTEES

Reporting for the committees on Research, Standardization, Power Test Codes, Safety, and the Boiler Code, Messrs. Fulweiler, Monroe, Fernald, Berry, Graff, Cornelius, Jacobus, and Fish presented enthusiastic and convincing pleas for greater consideration to the technical activities represented by these committees, and called attention to the value of the work performed by them and to the prestige that such work had brought to the Society and to the engineering profession.

THE BUSINESS MEETING

A business meeting that will be long remembered by those who attended it as a model of significance and interest was held on Monday afternoon, December 4, President Potter presiding. While some of the reports had been previously presented at the Council meeting, the manner in which presentation was made before a large audience of interested members provoked favorable comment and served to focus attention on high spots.

President Potter, in his remarks opening the meeting, told of his visits to 37 Local Sections and 35 Student Branches, at which he had addressed more than 10,000 engineers. These visits, he said, had impressed him with the "high quality of the members and with their deep interest in the welfare and prestige of the Society."

On the matter of finances he said:

The shrinkage in receipts made it necessary to reduce the expenditures for the year ending September 30, 1933, by $200,000 as compared with the year previous; also, it should be noted that the budget for the present fiscal year, which started October 1, 1933, is nearly $100,000 less than that of the year before, and only about one-third of the budget allowed for 1929–30. While drastic curtailments had to be made in all expenditures, every effort has been made to interfere with the major activities as little as possible.

The major accomplishments of the Society during his administration he spoke of as follows:

(1) Your Council has initiated a program intended to stimulate the capital-goods industries.

(2) Your Council has approved the Code of Fair Competition for the Professional Engineering Division of the Construction Industry, which approval carries with it a responsibility for our Society to participate in the Board of Control which will administer the provisions of the Code.

(3) Your Council has authorized the formation of a committee to prepare a manual of engineering practise which, it is hoped, will clarify the problems relating to the consulting engineer who is called in to aid in the design, construction, and installation of mechanical equipment and of engineering work by manufacturers.

(4) Your Society is actively participating in the Engineers' Council for Professional Development, which has as its major objective better preparation and greater prestige for the engineer.

(5) During the past year your Council has approved the model law for the registration of professional engineers and surveyors.

(6) Your Society has been active in unemployment relief, and it is the belief of those directly concerned with this problem that the individual engineer must acquire greater skill in creating and in finding new employment.

(7) Your Society is actively cooperating with the other founder engineering societies in a program for unifying the engineering profession.

(8) Your Council has authorized the appointment of a special committee on Junior Participation, as it recognizes the increasing importance of junior members to our Society.

(9) An innovation in connection with this meeting is that the first session held this morning was a joint meeting of your Council, of representatives of Local Sections, and of chairmen of Divisions and committees. The present arrangement is an opportunity for frank and free discussion of problems of policy by those who are actively participating in the work of your Society.

(10) *The Engineering Index* will be discontinued at the end of the calendar year 1933 unless support comes from outside the A.S.M.E.

(11) The new student-branch plan, already in effect in four areas, is to be extended to an additional region during the present Society year. Your Society has been most helpful to more than 100 engineering colleges in connection with their educational programs in preparation for entry to our profession.

(12) The past year has brought about added responsibilities to the representative of your Society in Washington, the American Engineering Council, which has been active in connection with the problems as they affect our profession through the programs of the National Industrial Recovery Administration, the Federal Public Works Administration, the Tennessee Valley Authority, and the Agricultural Adjustment Administration. There is a definite need for the type of activity in Washington as represented by the American Engineering Council. Unfortunately, the appropriations by your Society to this important service had to be reduced to about one-third of that allowed three years ago.

(13) The reports of the several committees and divisions should prove helpful to you in keeping you fully informed of the important work of your Society.

(14) Among the most important and significant contributions during the past year are the activities of a special committee of your Society on Policies and Budgets. This committee is endeavoring to appraise the aims and objectives of your Society and to offer suggestions which should prove helpful in shaping its future policies. The importance of the work of this committee led your officers to give its chairman a definite place on the program of this meeting.

REPORT OF COUNCIL

Past-President Roy V. Wright was called upon by President Potter to present the report of the Council. He said in part:

It has been a very trying year as you all recognize. President Potter has pointed out that it is necessary, with our set-up, for the budget to

be drawn up months in advance of the time when it becomes effective. With the rapid changes that we have had in this past year—downward so far as finances are concerned—the Council found itself in a very delicate situation and through its Executive Committee had to set up an extremely sensitive control so that almost week by week we could measure exactly what had happened during that period and readjust our expenditures to suit a duly adjusted budget. This has required a great deal of thorough and careful study.

We may have made mistakes, but the thing that we have always kept before us is, "How can we make these cuts and still continue to render the largest possible service to members?" Service to the member has been the acid test that we have tried to apply in readjusting the budget.

Two and one-half years ago, realizing the direction in which we might go, we made a thorough analysis and study of our administration, and we have quite radically changed the whole administrative processes of the Society in order to meet these requirements that have come to us with the falling off of our income.

I want to commend President Potter for the remarkable piece of work that he has done under these trying circumstances. He has come to every Executive Committee meeting. In an energetic way he has worked to the limit of his strength. He is entitled to a great deal of credit.

I wish there were time to tell you of some of the work that has been done by some other members of the Society who have given of their strength and what means they had or could afford in attempting to steer the Society safely through these difficult days. In spite of all the difficulties we have had to fight, in spite of the falling off of the income, we have taken some long strides forward in constructive work, and these promise to mean much in raising the status of the profession and in protecting the interests of the individual members of our Society.

FINANCES

Harold V. Coes presented the report of the Committee on Finance. He said in part:

The financial problems incident to the depression have caused the Society's management, as it has business institutions in general, to make drastic reductions in expenses, salaries, wages, and services rendered in order to keep the Society solvent. In spite of the heavy retrenchment in expenditures that had previously been made, a further drastic reduction during the year was necessary. An endeavor was made to do this without crippling the Society's activities.

It is a fact that the Society has to plan its activities and make substantial commitments before it has reliable information available, other than that of preceding years, as to what its income is likely to be. With the unprecedented reduction in income from its commercial activities and the most abnormal delinquency in dues, it has been almost impossible for the Finance Committee to budget either intelligently or practically.

The activities of the Society and its service to its members are financed from three main sources: (1) dues from members, (2) commercial activities, and (3) interest from securities owned. Income from commercial activities, particularly advertising, is beyond the control of both the membership and the management. Income from dues, however, is a membership responsibility.

A reduction of 26 per cent in the operating expenses of the Society was made during the past year. This has been largely accomplished by reducing the personnel and the compensation. Since October 31, 1931, the staff, exclusive of that of *The Engineering Index*, has been reduced from 107 to 68. *The Engineering Index* staff has been reduced from 36 to 18. As is customary, a committee of the Executive Committee reviewed the salary and wage rolls and reported that the salaries and wages were in line with current rates for similar occupations and responsibilities, except for the principal executives, whose salaries are lower than the going rates in solvent institutions and businesses. The percentage reductions in salary rates from the 1929–1930 high level range from 40 per cent for those in supervisory positions to 22 per cent for those in the lower brackets. As a result, the total salary expense, Society and Index, has been reduced from $282,300 (1929–1930) to $173,500, or 42 per cent.

The total income, 1932–1933, per member from all sources, including net reduction from reserve of $1.56, was $21.84. Of this the members supplied from dues paid $10.79 average per member and $0.63 from initiation fees, or a total income from membership dues and fees of $11.42 per member. If we exclude advertising and sales expense, *The Engineering Index*, and interest paid on borrowed money, we shall find that the total direct cost of service to members for general service, technical service, meetings, Local Sections, Professional Divisions, publications text, research, etc. amounted to $13.30 per member. On the basis of dues paid only, the average dues paid in per member failed to support the above activities by $2.51 per member.

The advertising and sales income was $6.14, *The Engineering Index* $1.78, a total of $7.92 per member, and the corresponding costs were $5.92 and $2.20, respectively, or $8.12, a loss of $0.20 per member.

Comparing advertising and sales income and expense shows a net gain of $0.22 per member which could have gone to aid the deficit in the direct service to members of $2.51. However, this gain in publications and sales income of $0.22 was offset by a loss in *The Engineering Index* operation of $0.42 per member, or a net loss of $0.20 per member, which checks with the $0.20 loss per member previously referred to. Thus the deficit resulting from the cost of direct service to members of $2.51 was, as a matter of fact, financed out of $1.56 charged to surplus account.

With a well-established program of economy, the Society needs only the support of the members in the payment of dues to pay off its bank loans of $164,000, release its pledged collateral, and operate within its income.

Bear in mind that at the beginning of this fiscal year, October 1, 1932, 5737 members owed the Society for dues $110,867, of which $55,000 was written off. Upon recommendation f the Finance Committee, the Council set up a reserve of $115,000 for the uncollected 1933 dues as shown on the income statement, Exhibit A. As shown in Exhibit C, the dues receivable is carried at $12,101, which, it is believed, is less than the amount that will actually be collected.

To show how important the income from dues is, if it had been possible for every member in arrears at the beginning of the year to have paid his account owing to the Society, the total income would have exceeded the total expenses by approximately $181,000, and the Society would have been out of debt. If the amounts due to the Society for 1933 dues alone had been paid in full, a surplus of approximately $70,000 would have resulted, which would have nearly halved the bank indebtedness.

The balance sheet has been cleaned up by charging to the surplus account $165,577, write-offs for bad debts, dues uncollected, obsolete inventory of supplies, and publication for sale. This amount, together with the charge against surplus for the current year's deficit, reduced the surplus account to $205,304. As a result, the balance sheet shows current assets of $503,834 and current liabilities of $263,198, or working capital of $240,635.

POLICIES AND BUDGET

Speaking for the Committee on Policies and Budget, its chairman, Harry R. Westcott, said, in part:

You will better understand the work of the Committee on Policies and Budget when I tell you that the first report of the Committee was adopted by Council at Chicago last June almost *in toto*. The report of Council gives the recommendations of that report. Those recommendations in conjunction with the aid and cooperation lent the Finance Committee in shaping the annual budget made possible the Society's operation during the current year.

The Committee on Policies and Budget is already engaged in a study of the years ahead. First we must envision the future. What will it be like? Shall we progress or retrogress? What will be the effect on our profession of such great forces as government, sociology, economics, business science, and education?

We are turning to the thoughtful leaders of America for the answers to these questions. We shall endeavor to picture what the future may be like. We shall then endeavor to picture what our profession and our Society should be like.

Second, we shall restate the fifty-three-year-old purposes of this Society which have guided us so well in the past and reaffirm our faith in them. All will again be pressed into active service for the purpose of creating a better Society. Fifty-three-year-old purposes may require new or renewed policies for carrying out those purposes. Every activity of this Society will be examined. Every policy will be tested.

Third, in shaping the policies for the future we shall remember that

science and technology, organization and management, are the bases of future prosperity in America. We shall remember that a refinement process rather than an expansion program will probably be the controlling force in industry. We believe that the engineer will play a greater rôle in the future than in the past. We shall remember that the engineer has suffered severely because of this depression and that the greatest good our Society can do will be to undertake his rehabilitation.

While we may have been charged with being grossly materialistic in our first report, I can assure you that you will find our second report finely idealistic.

The American Society of Mechanical Engineers is charged with the responsibility of advancing our profession; and to it our profession looks for guidance and inspiration. If we are to fulfil this responsibility, it is obvious that we must and should give all that we can in studied thoughtfulness. Such is the purpose of the committee.

WORCESTER REED WARNER MEDAL

PUBLICATIONS AND E.C.P.D.

L. C. Morrow, speaking for the Committee on Publications, repeated the proposals for issuing the *Transactions* as a monthly publication, which he had previously discussed at the Council meeting.

Readers of MECHANICAL ENGINEERING have been informed recently of the progress made by the Engineers' Council for Professional Development, and in an early issue it is hoped to print verbatim the first annual report of that body. For these reasons, no attempt will be made at this time to summarize the remarks made by C. F. Hirshfeld, chairman, E.C.P.D., at the A.S.M.E. Business Meeting.

COORDINATION

Speaking for a committee, of which he is chairman, representing the Founder Societies, W. L. Batt said, in part:

Let me talk with you for a moment about these joint activities of which we are part. In the first place, there is that body known as United Engineering Trustees, owner of the properties left by Andrew Carnegie to the four Founder Societies; a body of twelve made up of representatives from each of the four Founder Societies. Under its charter it has three principal departments, Engineering Foundation, Engineering Library, and the Employment Service. Then there is that notable joint activity of which only three of the Founder Societies are participants, the American Engineering Council. Also there is that joint activity, the Engineers' Council for Professional Development. In addition, there are numerous other activities in which we join with other bodies, such as the American Standards Association and numerous medal boards.

These joint activities have grown up over a period of years. No one of them has much relation to any of the others. There has been a certain inevitable overlap of their interests and responsibilities. This has not precisely caused friction, but a lack of homogeneity has limited the growth of engineering as a profession. We have no unity in this profession which characterizes it as the American Medical Association characterizes the medical profession. There is no respect on the part of the public for this profession as we should like to see it, and, in my opinion, we are not likely to be accorded that respect until we demonstrate that we are able to maintain for ourselves those same standards of efficiency which we, as engineers, insist upon in those industrial or professional undertakings with which we are associated.

Those of you who have followed the engineering profession for a number of years are familiar with the history of offshoots of societies. Numerous articles have been written on the great numbers of societies with their wide diversity of activity. There is no evidence that there is any concerted movement toward a unified engineering profession. I regret to say that one constantly runs against individual interests and misunderstandings which definitely limit the growth of the engineering profession.

The committee of which I am a part is made up of representatives of each of the four Founder Societies and from United Engineering Trustees. It is attempting to find a least common denominator which will afford a basis for a forward movement of the engineering profession. It calls for the support of the membership of the Founder Societies, and that is why I am glad to have this opportunity of talking to you today.

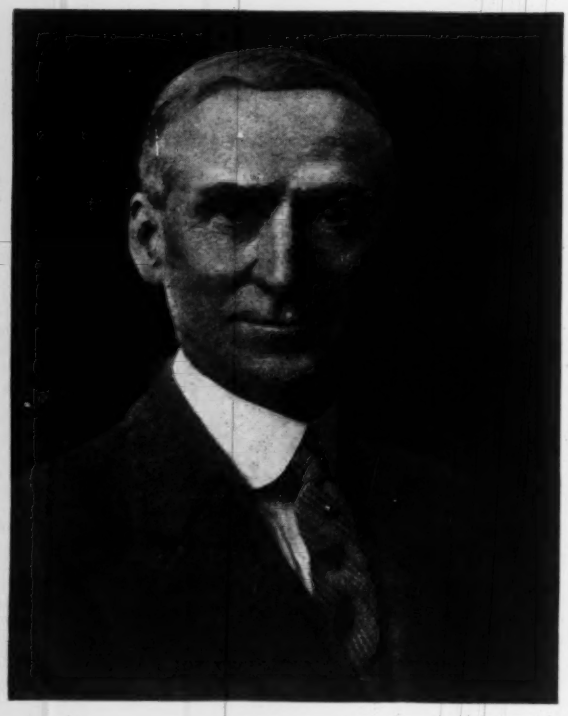
I hesitate to believe that the 50,000 members of the four Founder Societies have no interest in a single mechanism by which those societies may speak for the profession. I do not believe that our members are lacking in interest in the unification of the engineering profession. Therefore, may I beg of you as you meet the members of the other Founder Societies over the country to discuss with them the need for a closer unity of the engineering societies of the country.

And let us not confine our thinking to the four Founder Societies, because a casual survey of the statistics must lead one inevitably to conclude that there are many other national societies which must have a part in any forward movement of the profession as a whole. This is not a selfish movement. It is a movement which requires an unselfish devotion on the part of the members of all societies throughout the country.

CAPITAL-GOODS INDUSTRIES

L. P. Alford presented a progress report of the newly formed Committee on the Capital-Goods Industries. He said in part:

On September 22, 1933, the Executive Committee of Council of The American Society of Mechanical Engineers voted to order a study of the capital-goods industries, inasmuch as the low rate of employment in



DEXTER S. KIMBALL

these industries "is causing great hardship among mechanical engineers....." The resolution of the Council committee reads:

"VOTED: To appoint a committee on the Development of the Capital-Goods Industries, to formulate and execute a program as promptly as possible, without expense to the Society, and to report results to the Executive Committee at its next meeting."

The suggestions of the committee under this resolution are: (*a*) study of basic economic factors involved, (*b*) close cooperation with the American Engineering Council, (*c*) stimulation of country-wide discussion through meetings of Sections, (*d*) cooperation with all local engineering and industrial groups, and (*e*) publicity.

In carrying out the instructions of the Executive Committee, the Committee on Capital-Goods Industries made immediate contact with the American Engineering Council, and thus with the viewpoint of the National Administration, so far as that had been revealed. At that time there was little interest in the situation of the capital-goods industries in Administration circles. That attitude has since changed. Furthermore, the opinion seemed to be firmly held by many in the Administration that there is little labor content in the production and installation of mechanical equipment, the output of the capital-goods industries.

Your committee, therefore, initiated a study of mechanical equipment to determine the labor content in its manufacture and erection. That investigation has not advanced far enough to permit a progress report.

Your committee also undertook to discuss the attitude of manufacturers toward the purchase of new equipment and to determine the restraining influences in the situation. The assay was planned for six industrial cities: Philadelphia, Pa., Worcester, Mass., Cleveland, Ohio, Milwaukee, Wis., St. Louis, Mo., and Atlanta, Ga. Local members of the A.S.M.E. were asked to assist, and the Committee expresses its gratitude and appreciation for all the help afforded.

THE 1933–1934 COUNCIL

On Friday morning, President Potter called the 1932–1933 Council together for its last meeting to transact such business as remained for it to do.

Mr. Morrow presented the recommendations of the Committee on Publications regarding a new plan of distributing the Transactions, and appropriate action was taken as already noted in this report.

Dean Brigman presented a number of resolutions emanating from the Local Sections' Conference. These were referred to the committees concerned.

President Potter announced appointment of a Committee on Citizenship with the personnel as follows: Dean A. R. Cullimore, chairman, Roy V. Wright, W. H. Winterrowd, Lillian M. Gilbreth, and J. W. Roe.

The A.S.M.E. representation on the American Engineering Council was announced as follows: Paul Doty, chairman, L. P. Alford, R. E. Flanders, D. Robert Yarnall, A. A. Potter, and J. W. Roe, alternate.

President Potter then turned over the chair to President Doty, who called the new Council to order with appropriate words of welcome. In order to impress upon the Council the duties and privileges of its officers, President Doty presented each of the vice-presidents with a gavel of authority, and subsequently, throughout the meeting, called upon them in turn to occupy the chair.

The Executive Committee of Council for 1933–1934 was announced as follows: Paul Doty, chairman, Roy V. Wright, vice-chairman, Harold V. Coes, William L. Batt, Harry R. Westcott, and James A. Hall. Calvin W. Rice was elected secretary and Erik Oberg treasurer for the year 1933–1934.

A committee to "adopt a member," was set up by President Doty with James D. Cunningham as chairman.

The following appointments on standing and special committees were announced (unless otherwise indicated, the terms are for five years): Awards, L. P. Alford; Constitution and By-Laws, W. H. Kavanaugh; Education and Training, John Younger; Library, L. K. Sillcox (4-year term); Local Sections, W. R. Woolrich; Membership, Harlan A. Pratt; Power Test Codes, Hans Dahlstrand, Geo. A. Horne, Herbert Reynolds, and Edward N. Trump; Professional Conduct, Earl F. Scott; Professional Divisions, Crosby Field; Relations With Colleges, William A. Hanley; Safety, Harold L. Miner; Standardization, Walter Samans; Boiler Code (1-year term), F. R. Low, chairman, D. S. Jacobus, vice-chairman, C. W. Obert, honorary secretary, H. E. Aldrich, W. H. Boehm, R. E. Cecil, F. S. Clark, W. F. Durand, E. R. Fish, V. M. Frost, C. E. Gorton, A. M. Greene, Jr., F. B. Howell, J. O. Leech, M. F. Moore, I. E. Moultrop, C. O. Myers, H. B. Oatley, James Partington, C. L. Warwick, A. C. Weigel, and H. LeRoy Whitney; Honorary members: F. W. Dean, T. E. Durban, C. L. Huston, W. F. Kiesel, Jr., and H. H. Vaughan; Executive Committee of Power Division, J. C. Hobbs.

NON-TECHNICAL SESSIONS

On Tuesday afternoon, David Cushman Coyle, engineer-economist, delivered the Henry Robinson Towne Lecture on the relation of economics and engineering. Mr. Coyle's address is printed in full elsewhere in this issue.

PRESIDENT'S NIGHT

President Potter delivered the customary presidential address, which will be found as the leading article in this issue, on Tuesday evening, following which he introduced President-Elect Paul Doty.

Kenneth H. Condit, chairman of the Committee on Awards, then presented Townsend Tinker, condenser engineer, Ross Heater and Manufacturing Co., Buffalo, N. Y., for the Junior Award, granted for his paper, "Surface Condenser Design and Operating Characteristics." President Potter conferred the award.

Members of the Nominating Committee for 1934–1935, representatives and alternates, respectively, were announced as follows: Group I, Willard Freeland, William K. Simpson; Group II, Collins P. Bliss, D. Moffat Myers; Group III, K. M. Irwin, A. G. Christie, 1st alternate, A. I. Lipetz, 2nd alternate; Group IV, J. M. Foster, J. M. Gilfillan; Group V, Louis A. Cornelius, A. N. Goddard; Group VI, F. B. Orr, C. C. Wilcox; Group VII, Frank Prouty, L. D. Crain, 1st alternate, Frank A. Lockwood, 2nd alternate.

Following a reception, in which members of the Society and guests had an opportunity to meet President and Mrs. Potter, and President-Elect and Mrs. Doty, there was dancing.

ANNUAL DINNER

On Wednesday evening, at the Hotel Astor, the Annual Dinner to New Members was held. The charge to newly elected members was read by Secretary Calvin W. Rice, following which President-Elect Doty was introduced and spoke briefly.

Kenneth H. Condit presented the following members who received the special badges for fifty-year members of the A.S.M.E.: Charles W. Bray, Francis W. Dean, William F. Durand, Henry D. Hibbard, William Hill, Walter M. McFarland, Frederick A. Scheffler, Thomas B. Stearns, George A. Suter, Edward A. Uehling, Hosea Webster, Jay M. Whitham, and Frederick N. Willson.

The address of the evening, which will be found elsewhere in this issue, was delivered by the Hon. John Dickinson, The Assistant Secretary of Commerce, on "Capital-Goods Industries."

The formal program was completed with the conferring of the following medals: The A.S.M.E. Gold Medal to Ambrose Swasey, "for his contributions to the advancement of the engineering profession and for his part in the development of the turret lathe and the astronomical telescope;" the Worcester Reed Warner Medal to Dexter S. Kimball "for his contributions to efficiency in management as exemplified by his recently revised 'Principles of Industrial Organization,' and by his many articles, engineering-society papers, and public addresses;" and the Melville Medal to William E. Caldwell, for his paper "Characteristics of Large Hell Gate Direct-Fired Boiler Units." Citations for the awards were made by Ralph E. Flanders, in the case of Mr. Swasey, and by Dr. William F. Durand and William L. Abbott in the cases of Dean Kimball and Mr. Caldwell, respectively. President Potter conferred the Awards.

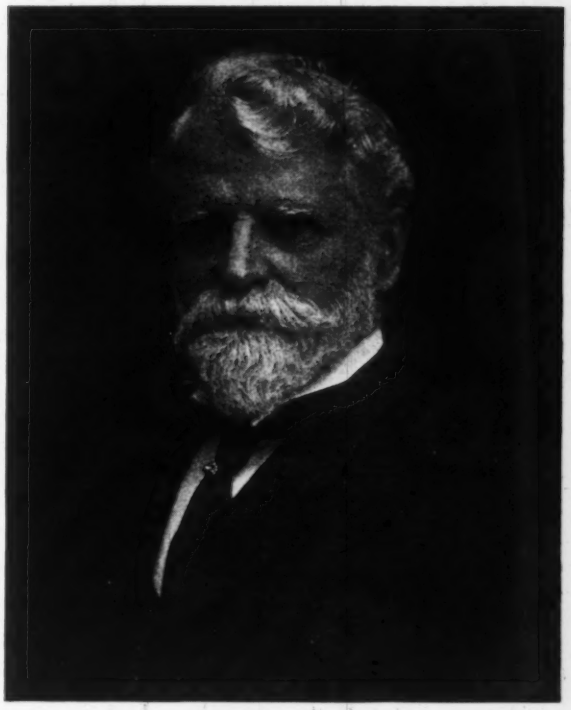
Dancing followed the dinner.

TECHNICAL COMMITTEE MEETINGS

Increased interest was shown this year in the meetings of the technical committees. A total of 45 meetings were held: Research 15, Standards 19, Power Test Codes 3, Safety 2, and A.S.T.M. 6. The total attendance at these meetings was 538.

STANDARDIZATION

In the standards group with total attendance of 273, the meeting of the Sectional Committee on Drawings and Drafting-Room Practise, Dean F. DeR. Furman, chairman, was probably the most significant since it marked the completion of five years' work. At this meeting the report of the editing committee was presented by Prof. T. E. French, chairman, and was fully discussed. When revised, the proposed American Standard will be sent to the members of the committee for vote on approval by letter ballot. Another important meeting was that of Technical Committee No. 3 on Machine Tapers, F. S. Blackall, chairman, which reported with some satisfaction the completion of its proposal for an American Standard for Self-Holding (Slow) Machine Tapers.



AMBROSE SWASEY

Under the sponsorship of the Committee for the Classification and Designation of Surface Qualities, five meetings of subcommittees and subgroups were held during the week. The Sectional Committee on the Standardization of Small Tools and Machine-Tool Elements, C. W. Spicer, chairman, also carried through a group of six technical committee meetings, including the annual meeting of the Sectional Committee.

The progress made at Chicago last June by the Subcommittee on Tolerance Systems, R. E. W. Harrison, chairman, of the Sectional Committee on Allowances and Tolerances for Cylindrical Parts and Limit Gages, was added to during a meeting of the subcommittee on Thursday.

The A.S.M.E. Standards Luncheon seems now to have become an established feature of the Annual Meeting. This year this luncheon had 35 in attendance and it had the distinction of entertaining President A. A. Potter and President-Elect Paul Doty, both of whom made brief addresses.

At the luncheon meeting of the A.S.M.E. Standardization Committee, called by Chairman W. S. Monroe on Monday, the principal actions were the approval of the proposal to recommend to the American Standards Association the establishment of a standard viscosity classification system for industrial lubricants and the election of Prof. Earle Buckingham as Mr. Monroe's successor to the chairmanship. Mr. Walter Samans is the new member of the Standardization Committee.

On Thursday afternoon an important meeting was held by Subcommittee No. 4 on Materials and Stresses, A. M. Houser, chairman, of the Sectional Committee on Pipe Flanges and Fittings. This dealt with the year-old discussion on adjusted service pressures for a temperature range above and below 750 F for the standard steel pipe flanges and fittings. Subgroup on Welding Flanges, L. D. Burritt, chairman, met also and revised the preliminary draft of the proposed American Standard for Welding Flanges on the basis of the comments received from industry.

(*Continued on page 62*)

MECHANICAL ENGINEERING

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GEORGE A. STETSON, *Editor*

The Engineering Survey

IT WILL be noticed that quite a few abstracts in this issue are devoted to two subjects—marine engineering and the Diesel engine. The Engineering Survey is essentially a reflection of the major activities in the field of engineering. From time to time a branch of engineering is particularly actively developed. Novelties of development usually indicate a revival of activities and research, a preparation for such a revival, or possibly the completion of a previous cycle. In both marine engineering and the Diesel-engine field there have been and are going on many important changes reflected as usual in an increase of important articles devoted to these subjects. Hence their prominent occurrence in the abstracts published in the Engineering Survey.

A Unique Memorial

ON OCTOBER 29, 1933, at Worthington, N. Y., a suburb of New York City, there was held a service commemorating the fiftieth anniversary of the founding of the Church of St. Joseph of Arimathea. This church was erected by Sarah Newton Worthington in memory of her husband, Henry Rossiter Worthington, Honorary Member in Perpetuity of The American Society of Mechanical Engineers, the hydraulic engineer who founded the duplex-pump industry and the great works which bear his name.

In the program of special services that celebrated this historic event the rector has written: "As far as our knowledge goes, it is the only church erected as a memorial to an engineer."

This is indeed a unique distinction. Engineers are well known as patrons of churches and as communicants. A hasty search fails to reveal another case in which an engineer has been so remembered. If such cases exist, it would be interesting to learn about them.

H. M. Martin

AN EMINENT ENGINEER once said that an editor was one who knew less and less about more and more. However justly this may have been applied at the time to the particular object of his quip, editors such as the late H. M. Martin, who served our British contemporary, *Engineering*, brilliantly for more than forty-five years, are not deserving of being considered in such a category. For it was Mr. Martin's enviable ability not only to appraise and criticize the writings of others but to make numerous instructive and original contributions to many fields of engineering literature.

In accordance with the custom of British journals, Mr. Martin's name did not appear on the "mast-head" of the paper he served, nor was it frequently attached to the articles that came from his pen. But this anonymity could not hide from those who were familiar with his interests the fact that he was indubitably the author of many "leading articles" and other unsigned contributions in *Engineering*.

The range of subjects on which Mr. Martin wrote and of which he had more than an "editorial" knowledge is impressive, for he carried on much original work in addition to his writing. These related to such diverse subjects as the theory of the short cylindrical boiler, the strength of hooks, the strength of rotating disks, steam leakage through labyrinth packings, the lubrication of gear teeth, the theory of steam nozzles, laws of heat transfer in condenser tubes, bridges, and masonry dams. To many engineers in this country he was well-known for his knowledge of and writings on thermodynamics, including particularly the steam turbine. The engineering and the editorial professions have lost heavily in his death.

Generation of Hydrogen

IN CONNECTION with the manufacture of hydrogen on a large scale at the Billingham Fertilizer Factory of the Imperial Chemical Industries, Ltd., it is proposed to use this hydrogen in the hydrogenation of coal, and hence the question of the possibility of generating hydrogen cheaply has been raised. W. E. Mordecai, manager of the Bear Park Coal and Coke Company's Chemical Works, in County Durham, has drawn attention to the possibility of obtaining cheap supplies of hydrogen from coke-oven plants. He stated that it is not difficult to evolve projects for the commercial hydrogenation of tar and oils at the oven, especially if there are, in conjunction with it, arrangements to utilize surplus gas for the manufacture of organic chemicals or for transportation uses. Another proposal is to generate hydrogen by electricity using off-peak power.

The central station would like to be able to operate at a uniform load throughout the day and night, but under present conditions this cannot be had. Therefore, arrangements must be made to carry the peak load. This is generally done by providing what is known as the base-load power plant which is usually equipped with the largest and most economical units that can be obtained. To this a less expensive and less economical peak-load unit is added. The lower economy is partially justified by the fact that the peak-load plant does not operate continuously, and, therefore, operating economy can be sacrificed for low overhead expense. Should such an industry as the manufacture of hydrogen develop on a large scale, however, electric power plants might be designed without peak-load units. Then in peak-load

hours the entire output of the plant would be distributed to the users of electric energy, while in off-peak hours the plant could manufacture such chemicals as hydrogen. The question is chiefly one of economy. If hydrogen can be sold for enough to pay the costs of its manufacture, the proposition might be worth considering. If even a slight profit could be made on the hydrogen, the economy of the central station would be materially improved. If, however, hydrogen would have to be sold at a loss, it would be necessary to determine whether the benefits of greater operating economy would be sufficient to compensate for the loss on that part of its operation which produces hydrogen.

Give and Take

THIS OFT-USED expression comes fittingly to mind in thinking over certain aspects of the recent Annual Meeting of The American Society of Mechanical Engineers. It is appropriate in two different meanings.

First, in the most widely used sense of the expression, there was considerable give and take among earnest members of the Society in the discussion of its problems and of the relative value of the work carried on by various groups. It frequently appeared that some of these groups were being put on the defensive by their critics and that in the give and take of the discussion misunderstandings were cleared up and actions and points of view justified or rationally explained. Such give and take seems highly desirable and an indication of a wholesome frankness and sincere loyalty on both sides. Critics and questioners who come into the open, speaking their minds and searching for truth in manly fashion, are entitled to respectful answers and arguments and generally make useful suggestions and assist progress toward desired objectives. The residuum of better feeling and clearer understanding that came out of the give and take of the Annual Meeting is one of the greatest benefits that will have been derived from it.

Similarly, the give and take that abounds in any worthwhile discussion of technical papers is the most important reason for maintaining the forum of public presentation that the Annual Meeting affords. The livelier the discussion and the more points of view expressed, challenged, and defended, the greater are the dividends of professional profit and pleasure carried away by participants and auditors. And in this connection it is to the everlasting credit of engineering societies that discussions are carried on in such meetings without personal malice or cheap tricks of argumentation that substitute irrelevant attacks on individuals for airing views on the technical merits of the subject.

The other sense in which give and take seems appropriately applied to the recent meeting is a more literal one. Among the members individually, and as they assort themselves into groups of various kinds, the dual rôles of giving and taking are differently played. Every member makes his contribution, whether of money, or time, or knowledge and experience, according to his interests, capabilities, and opportunities; and every member finds himself also on the receiving end of the process, with tangible and intangible receipts in accordance with a distribution factor applicable solely to himself. The difficulty arises when individuals think of themselves, and others, as belonging exclusively to one or the other of these categories of members, those who give and those who take, without inquiring too carefully into what, actually, is given, and what taken. The member who insists on measuring both receipts and expenditures in terms of a single unit, be it money, service, or knowledge, is likely to find unbalanced accounts, while one who will make use of all three of these units, with properly weighted correlation factors, may come much nearer a balance. This is not to say that, by any method of accounts, some members do not give more and others take more, but it does suggest the dangers of partial analysis.

The philosophy of give and take was admirably brought out in a discussion of the new plan for distributing the *Transactions* of the Society when it was suggested that perhaps the committees whose duty it was to secure papers and build up technical programs thought too exclusively of making available a maximum amount of technical information, while the member on the receiving end of this process might be better served by a plan which would insure a greater number of papers coming directly to him. And this is what the new plan makes possible. For a given sum of money, fewer papers can be published, but the member will receive more pages of published material every year than under the former plan. This is a balancing of give and take which seems to achieve desirable results.

Many Points of View

A TOO pliantly responsive reader of the principal contributions to this month's MECHANICAL ENGINEERING will find himself in the position of that fabulous horseman who rode off furiously in opposite directions. For if he agrees with the philosophy of Mr. Coyle, how shall he reconcile it with Mr. Jordan's?

An open-minded person, unable effectively to controvert or to subscribe to all of the implications of these two writers, can but naturally enough wish that he might be comfortably dogmatic by reason of holding unassailable convictions, just as the rider on horseback probably would have been willing to change his absurd and impossible position for a seat in a single-track railway train, even if it were going in the wrong direction. Bishop Blougram showed how the mind that had substituted unbelief for belief found itself assailed by doubts as before, with belief playing the rôle of unbelief. And so with economic doctrine there's "that plaguy hundredth chance, Strauss may be wrong."

In an age when our most sacred physical constant, the velocity of light, has been shown to possess cyclical irregularities, there may be celestial authority for variation in such mundane matters as the social and economic verities. On the other hand, the differences may not be as great as they appear to be.

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICS

Alcohol as Fuel in Aviation Engines

THE author discusses this subject in part from the Italian point of view. One of the advantages of alcohol is that it can be made out of materials of domestic origin. There was some advantage in using alcohol in aviation engines in the earlier days as a higher compression than with gasoline could thereby be obtained. With the present anti-detonants, however, this advantage has lost a good deal of its value. The author believes that in order to utilize alcohol as a fuel, recourse would have to be had to the Diesel-type engines. Should it be so used, the new type will be at a disadvantage as compared with the Diesel fed with fuel oil because of the lower heat value of alcohol. On the other hand, however, it would appear that the volume of air necessary to burn alcohol is smaller than with fuel oil. It might be possible, therefore, to build alcohol Diesel engines with a smaller volume swept by the piston, and therefore of less weight. Even then the weight of the engine will be in excess of that of an engine of corresponding power fed with gasoline.

The author believes, however, that the Italian motor industry should carefully study the problem of using alcohol for engines other than those destined for aviation, that is, engines where the matter of specific weight is of less importance. (Col. G. A. Italo Raffaelli in *Rivista Aeronautica*, vol. 9, no. 4, April, 1933, pp. 1–3, 5)

Aviation Diesel Motor

THE Diesel aviation motor has certain advantages as compared with the conventional gasoline motor. [The author compares the Diesel motor throughout with the straight carburation type of gasoline or gasoline-benzol driven motor. He makes no references to safety fuels or ignition-compression motors.—EDITOR.] The fuel consumption of a Diesel motor is lower than that of the carburetor motor (170–180 g per hp-hr as compared with 230–250 g). On the other hand, the weight per unit of power is somewhat higher in the case of the Diesel (1.1 kg per hp as compared with an average 0.9 kg per hp). This is shown diagrammatically in the original article.

In addition to the alleged generally lesser fire hazard in the case of a Diesel, it is specifically stated that fires in the crankcase are much less apt to occur, because, should a piston break, the reduced compression will make it impossible for the fuel to ignite in the cylinder, while in a gasoline motor the ignition of the fuel will occur and may penetrate into the crankcase. Experience has shown that the entire motor may be put out of business by the ignition of the electron-metal crankcase.

The danger of freezing of fuel is also less in a Diesel because gas oil becomes viscous at —35 C (—31 F) and does not begin to solidify until —42 C (—43.6 F), while a gasoline-benzol mixture begins to freeze at temperatures from —12 to —27 C (10.4 to —16.4 F).

Furthermore, the Diesel motor is practically unaffected by the position of the plane in flight, while gasoline motors can obtain such freedom from effects of position only by employing floatless carburetors. Contrary to what happens in the case of a carburation motor, the Diesel is not adversely affected by changes of mixture in high flights. Because the supply of fuel to the various cylinders by the pumps is uniform, adjustment of injection is a simple matter, while carburation motors must be adjusted so as to feed properly the poorest cylinder, and this results in an increased consumption of fuel throughout. This disadvantage, however, may be obviated by providing means for the injection of gasoline into the cylinders. The heat loss to the cooling water per horsepower developed is said to be smaller in the Diesel engine than in the carburation motor, because of the greater excess of air used and the higher degree of expansion. For the same reasons the temperature of the exhaust gases is lower in the case of a Diesel than in the case of a carburetor motor. Because of these two facts, the weight of cooling water in a water-cooled Diesel aviation motor is less than in a gasoline motor. A curve in the original shows that for a 600-hp motor the total weight of a motor ready for operation and including its operating materials for a trip of, say, 600 km (373 miles) is less in a Diesel motor than in a carburetor motor. Because certain averages were used in plotting this curve, it cannot be applied except in certain average cases.

There are, however, certain disadvantages in using the Diesel process. The engine runs harder, which is particularly unpleasant when the engine is running idle. The higher pressures used require a correspondingly stronger construction. Next, the desirability of an aviation motor is affected not only by its weight per unit of performance but by its frontal resistance, which applies particularly to radial motors. The diameter of radial motors and the frontal resistance of in-line motors are, on an average, greater in the Diesel than in a carburetor motor of the same output.

Furthermore, the introduction of Diesel motors on a large scale has been greatly delayed by the necessity of a long development previous to putting the motors into production, estimated by the author as being in excess of three years, as well as the fact that hitherto the weight per unit of output of the Diesel has been comparatively high. The application of the Diesel process made it also necessary to solve numerous problems dealing with the strength of parts at high thermal strains brought about by the use of higher pressures.

The author proceeds next to the elaboration of methods for comparing the details of Diesel engines with those of carburation motors, basing his work on the weight per unit of output. He then considers the output per unit of volume contained in a stroke and gives the results in the form of curves.

He also considers the motors from the point of view of their efficiencies and gives expressions for the mean pressures of Diesel and carburetor motors. He shows that because of the fact that indicated efficiencies of Diesel motors are better than those of carburetor motors, the mean pressure in Diesel motors at constant excess of air is actually even more favorable than theoretical considerations would indicate. However, the Diesel process requires a very considerable excess of air, and this produces a material reduction in the mean effective pressure, as the efficiency of a perfect machine does not increase

in proportion to the excess of air, so that the indicated efficiency remains approximately constant. Assuming average values for carburetor and Diesel motors, it is found that the ratio of mean effective pressure of the Diesel to that of the carburetor motor is approximately 0.75. He claims that this shows that the lower mean effective pressures encountered with the Diesel process are due to the higher values of the excess of air. Although the average piston velocity is approximately the same in both types of motors, the revolutions in the Diesel are lower, because the ratio of stroke to bore is usually greater in the Diesel engine than in the other type (on the average 1.2 to 1.4 as compared to 1 to 1.2). Because of the high degree of compression which has to be employed with the Diesel cycle, it is difficult to produce a proper shape of combustion chamber where the ratio between stroke and bore is too small.

Moreover, whereas the speed of a Diesel engine is usually only from 1800 to 2000 rpm, there are several carburetor motors running at 2200 to 2700 rpm, which would indicate that there are still important possibilities in the development of Diesel engines.

The author discusses also the employment of the two-stroke-cycle process in aviation and describes several existing types of Diesels, paying particular attention to the French Jalbert motor. (Dr. of Engrg. Fritz A. F. Schmidt in *Zeitschrift des Vereines deutscher Ingenieure*, vol. 77, no. 44, Nov. 4, 1933, pp. 1183–1187, 12 figs., *dc*)

ENGINEERING MATERIALS (See also Machine-Shop Practise: Matrix Alloy in Tool and Die Making)

M.B.V. Surface Treatment for Aluminum and Its Alloys

THIS process is said to be extensively used in Germany and other countries and employs a bath composed of an aqueous solution of anhydrous sodium carbonate and anhydrous sodium chromate at a temperature of 90 to 100 C (194 to 212 F) in proper proportions, such as 5 per cent of the former and 1.5 per cent of the latter. The aluminum parts to be protected are placed in the solution for a period of from 3 to 5 min and are then washed in hot or cold water. The details of the process are given in the original article. It is said that the color of the film produced varies from light to dark gray and that the coating has a high protective action. The mechanical resistance of the coating is not exceptionally high, but the film is said to be very adherent and cannot be detached by folding, rolling, or pressure, as it possesses a high elasticity. A secondary treatment improves the corrosion resistance, but this process is not yet perfected. (Dr. Gustav Eckert, *The Chemical Age*, Metallurgical Section, vol. 29, no. 745, Oct. 7, 1933, pp. 23–24, *d*. The original article is based on a prize-winning essay in the 1932 International Aluminum Competition.)

FUELS AND FIRING (See also Aeronautics: Alcohol as Fuel in Aviation Engines)

The Cunard Coal-Oil Fuel

CONSIDERABLE attention was attracted to a series of trials carried out in 1932 on the Cunard liner *Scythia* with a new type of coal-oil fuel. The patent describing the process for the production of this fuel and containing the first complete information about it has just been published in England. The main factor in the Cunard process is the use of a specific type of oil as the dispersion medium, and though the coal need be ground to suspension size only, that is, just 100 per cent to pass through a 200-mesh sieve, no protective or peptizing agents need be added. The oil is defined as having a "fixed" carbon content of not less than 5 per cent and cracked fuel oils are mentioned as specially suited for the purpose. The test for fixed carbon content is quite specific to the Cunard process and exact details are given for carrying out this test. The degree of stability and the amount of coal which can be incorporated along with the oil are dependent on the fixed carbon content, the general relationship being that the higher the carbon content the greater the stability. For average purposes, a fixed carbon content of 6 per cent is sufficient. The coal employed should be of the bituminous type of reasonably low ash content. The Cunard process discovered the ability of certain types of oils to act themselves as a stabilizing medium, though the claim of the patent states that the coal should be pulverized to a degree of fineness such that it remains in stable suspension. (Part of an account of a paper read before the Institute of Marine Engineers by Dr. W. R. Ormandy, with the discussion which followed and associated matter. *The Steam Engineer*, vol. 3, no. 2, November, 1933, pp. 45–47 and 75, *dg*)

Combustion of Pulverized Coal

THIS is a continuation of an abstract published in the December, 1933, issue of MECHANICAL ENGINEERING, pp. 764–766.

The information previously published resulted in the formulation of a law establishing the relation between the duration of combustion of grains of all sizes. All grains can be considered as cubes of certain dimensions, and the author applied himself to the problem of determining the curve of combustion applicable to the case of large grains. The author assumed, for example, that if one of the grains burned during a time t sec and decreased in length by d mm, while another grain during time t' sec decreased d' mm, it may be concluded that a grain having any original length of side would decrease by $d' - d$ between the instants $t - t'$. Moreover, it would have to be admitted that the grain of side d would burn completely in a time t, and that the duration of combustion of a grain of side d' is t' sec. The author undertook, therefore, a series of experiments in which, as previously, the little lumps of coal were weighed and their sizes calculated, whereupon they were left in the furnace under similar conditions, but for different times. While they were all put into the furnace at the same time, they have been withdrawn one by one at certain intervals and the decrease in the lengths of their sides has been calculated for each one of them, the results of these calculations being given in a table in the original article with grains of anthracite and a furnace temperature of about 900 C (1652 F).

Quite a large number of experiments were carried out. An effort was made to keep the conditions uniform in order to see if a general law could be derived from a large number of tests. The results were plotted and it appeared that whereas the individual points were often scattered, a line of maximum frequencies developed, roughly parabolic in form, the x-axis of which was time and the y-axis decrease in dimensions. This curve would indicate that the combustion becomes slower as the inside of the grain is penetrated. This may be explained by the abundant combustion of the gases at the beginning, which rapidly decreases the weight of the grain, and the latter (in the method of calculation used by the author) was employed to determine the calculated numerical value of the length of the side of the cube. It is observed further that,

as the carbon is poorer and poorer in residual gases, it is more and more difficult to burn, and its point of ignition rises gradually.

The result is further complicated by the action of the ash which partially masks the surface of the grain. This is contrary to views expressed by Audibert, however.

The author expresses his parabola by the following equation:

$$y = 0.08x^{0.36}$$

where y is in millimeters and x in seconds.

From this the author proceeded to tests in a semi-industrial furnace. This part of the article is quite extensive and cannot be abstracted here because of lack of space. The author submits an explanation as to why the hottest point of the furnace is beyond the zone of maximum combustion.

The author claims that the major portion of the coal is burned within a limited section of the furnace and the rest of the furnace chamber merely burns an amount of coal of relatively little importance. The calculations which he derives therefrom may, in his estimation, lead to the determination of the most economical dimensions of a furnace that should be adopted. In this connection he calculates the combustion space in a furnace, and in an example shows the application of his principles by tests made on a furnace. He points out very strongly the disproportion between the combustion space that his figures show is necessary and the volume of combustion chambers in the ordinary furnace. He claims also that boilers with internal furnaces permit the development of a very much greater number of calories per cubic foot than ordinary boilers and attain values close to those indicated by his theory. (A. Biraud in *Chaleur et Industrie*, vol. 14, no. 157, May, 1933, pp. 209–217, 7 figs., *eA*)

"Carbolux" and "Anthraluc"

AT BRUAY, a low-temperature carbonization process has been worked out as a solution of a particular problem—that of disposing satisfactorily of dirty slack coal of a high volatile content, unsuited for the manufacture of metallurgical coke, for which, moreover, the demand is not good at present. The product, "carbolux," commands a good price as a substitute for expensive imported anthracite, for use in central heating boilers. A similar product, "anthraluc," is made in Belgium.

Ordinary coke ovens are used for the final carbonization, which is carried out at a flue temperature of 850 C, giving a temperature of 700 C in the charge. By using the narrowest ovens (350 mm = 11.8 in.) it has proved to be possible to carbonize the charge (which is dry) in 25 hr and to discharge it without difficulty. On discharge the carbolux does not break up like ordinary coke—there is no central plane of division, and no fissures. The use of standard coke ovens is obviously one of the strongest points in the process.

The oven charge is not, however, raw coal, but a blend of raw coal and semi-coke; the latter is made in rotary kilns of high output, concerning the design of which great secrecy is preserved. A double treatment is used, first a preheating (with oxidation to reduce the caking properties) at 350 C, then a carbonization at 475 C.

While the calorific value of carbolux is lower than that of anthracite, tests have shown that for certain reasons both give approximately equal results, weight for weight.

The principles underlying the process are not new and the merit lies in the careful way in which they have been selected and employed. The annual output of carbolux is at present 130,000 tons, obtained from 50 coke ovens. (Paper before the recent Congress of Industrial Heating at Paris, by Pamart. Compare Dr. Koppers' paper before the Institute of Fuels entitled, "Recent Developments in Coking Practice," the former being abstracted through *Fuel in Science and Practice*, vol. 12, no. 11, November, 1933, p. 364, *d*)

INTERNAL-COMBUSTION ENGINEERING (See also Aeronautics: Aviation Diesel Motor; Marine Engineering: Two-Stroke-Cycle Eight-Cylinder Marine Engine; Railroad Engineering: A "Diesel Boiler;" Diesel Traction)

Krupp Opposed-Piston Air-Cooled Diesel

THIS is a 50-hp Diesel of somewhat unconventional design. A tunnel-type crankcase is employed and two finned cast-iron cylinders are fitted horizontally on each side of it, so that the connecting rods of the two opposing cylinders work side by side on the same crankshaft throw. The crankshaft is supported in four plain bearings and carries on one end a blower which forces air through channels cast integrally with the crankcase into longitudinally finned funnels or flues surrounding each couple of cylinders. The air current is broken at right angles, and having cooled the cylinders around the combustion space, passes outward through the longitudinal fins of the cylinder heads and surrounding casing in the atmosphere. At normal working speed the blower supplies slightly more than 4 cu ft of air per sec. The pistons are of light metal alloy. The top edges of their crowns are cut away so that when they are in their outer dead-center position, a combustion chamber with a sloping inner wall is formed. A special type of Deckel injection pump with opposed plungers is employed. (E. P. A. Heinze, in *Diesel Power*, vol. 11, no. 11, November, 1933, pp. 713–714, 2 figs., *d*)

Sulzer Compound-Admission Four-Stroke-Cycle Diesel Engine

A PARTICULAR feature of this engine is what is claimed to be a new method of supercharging. In this engine a receiver is arranged along the whole length on the exhaust side. Air is supplied to this receiver from a double-acting air pump located at the end of the engine. This air enters the cylinder through ports having non-return valves and occupying approximately half the circumference at the lower end of the cylinder. The ports are uncovered by the working piston when it is at the bottom dead center, and air enters the cylinder through these ports at two periods during the cycle of operations. The first period is immediately after the opening of the exhaust valve. At this point the piston uncovers the air ports, and a certain quantity of air flows into the cylinder, forcing the exhaust gases in front of it and leaving a deep air cushion above the piston head. As the piston continues the exhaust stroke, this air is carried with it, expelling the exhaust gases from the cylinder and leaving the clearance space full of fresh air at the end of the exhaust stroke. The normal suction stroke follows, but just before the piston uncovers the ports, the suction valve is closed. This gives a slight vacuum in the cylinder which facilitates the flow of air through the ports after these have been uncovered by the piston. As a result, the air enters the cylinder from the receiver at a high velocity, and through its kinetic energy a larger charge of air enters than would otherwise be possible.

This cylinder-charging arrangement, which has been named the "compound-admission system," is claimed to be particularly suitable for stationary engines and for marine auxiliary

service. A curve of specific fuel consumption is given in the original article which would show at about 85 per cent load, a consumption of 0.376 lb per bhp-hr. (*The Marine Engineer*, vol. 56, no. 670, July, 1933, pp. 207–208, 3 figs., *d*)

MACHINE PARTS

Standage Beam-Type Resilient Universal Joint

THIS was shown at the Shipping, Engineering, and Machinery Exhibition held in London, Sept. 7 to 23, at Olympia, and has been fitted on both pleasure and commercial vehicles. These joints are said to be self-centering, maintain a constant angular velocity between driving and driven shafts, can be arranged to work through an included angle of 45 deg, and require no splined sleeve or similar device to accommodate the relative shortening of the propeller shaft owing to the axle

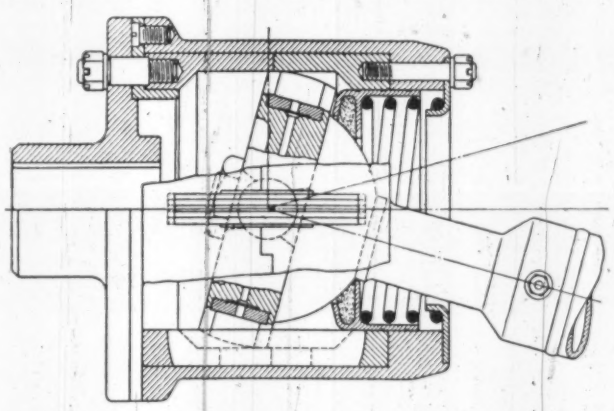

FIG. 1 STANDAGE BEAM-TYPE RESILIENT UNIVERSAL JOINT

rise. One of the illustrations shows a joint called by the makers the "cantilever" type. Laminated springs are located on the flange of the outer member and are engaged by the toothed inner member attached to the end of the propeller shaft. The flanged retaining ring merely serves to position the springs axially. A spring-backed ball mounted on a sleeve sliding in the hub of the outer member centers the inner member.

In another design, the "beam" type, the springs are supported on both ends in slots in the shell of the outer member. The toothed inner member is spherically ground on the periphery, and centers and slides in the bore of the outer shell. Oil is retained by a felt ring carried in a sliding sleeve in the end of the outer member and held up to a hemispherical surface behind the inner member by a spring.

A modification of this type, designed for the shaft between the two driving axles of a six-wheel trolley bus, is shown in Fig. 1. In this design the springs are engaged by slotted bearing plugs pivotally mounted in the inner member. (*The Automobile Engineer*, vol. 23, no. 311, October, 1933, pp. 364–365, 2 figs., *d*)

Design of Cylindrical Bearings

IN THE present paper, certain new views on the design of cylindrical bearings are presented. Frictional output N_r is now calculated usually by means of the formula $N_r \approx \mu Pu$ where the coefficient of friction μ may be replaced by the Gümbel function. Here P represents the force acting on the bearing and u the velocity at the journal. The author uses also η to denote the kinematic viscosity, ω angular velocity, h_0 the clearance space, and r the radius of the journal, $\psi = h_0/r$ being the average play in the bearing.

If, for the sake of comparison, one would plot the now available experimentally established data in the form of a function μ/ψ over the dimensionless coefficient $\frac{\eta\omega}{p\psi^2}$ on logarithmic paper as is done in Fig. 2, then for each bearing a definite characteristic line will be obtained and with a high value of the coefficient, this line will tend to approach a

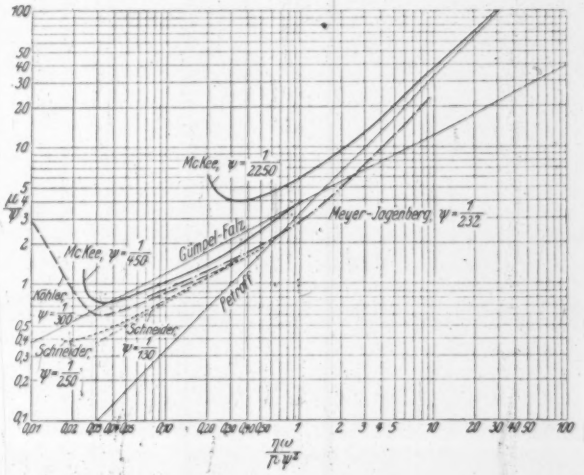

FIG. 2 FUNCTIONAL RELATIONSHIP BETWEEN THE BEARING COEFFICIENT $\frac{\eta\omega}{p\psi^2}$ AND $\frac{\mu}{\psi}$ ACCORDING TO VARIOUS INVESTIGATORS

straight line. The case of smaller lines is more or less covered by Gümbel's approximative equation. In many cases, however, it gives values that are too low, and in such cases Petroff's straight-line equation $\frac{\mu}{\psi} = \frac{\pi\eta\omega}{p\psi^2}$ seems to meet the case better.

The present author, after careful experimentation, has come to the conclusion that for low peripheral velocity such an equation as

$$\nu_r = \frac{\eta u^2}{h_0} + \frac{pu}{2000}$$

gives reliable data, and can be used instead of the more precise equation

$$\nu_r = \lambda + \frac{\eta u^2}{h_0}$$

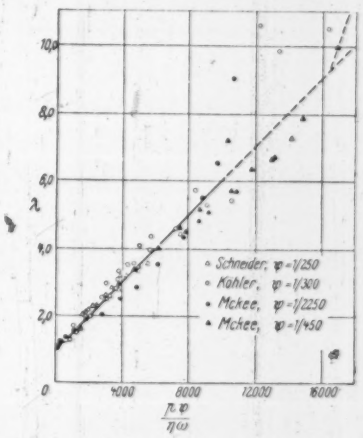

FIG. 3 COEFFICIENT λ OF A CYLINDRICAL SLIDING BEARING AS A FUNCTION OF $p\psi/\eta\omega$

The first part of this equation is supposed to take account of the hydrodynamic theory, and the second of practical experience. Here ν_r is the specific frictional effect per square meter of journal surface, p is the specific load on the journal, and λ is a dimensionless magnitude depending exclusively on the composition of the shaft, which is characterized by the coefficient $p\psi/\eta\omega$.

In Fig. 3 the value of the coefficient λ is plotted as a function of $p\psi/\eta\omega$ on the basis of several series of experiments, and good agreement is found with the previously assumed law, particularly for the specific case of $\lambda = 1$.

On the other hand, Fig. 4 shows the specific amount of friction ν_r as a function of $\eta\mu^2/h_0$, and compared with the Petroff straight line. From this it is observed that for larger values of journal velocities the value of ν_r approaches more closely the hyperbolic law. Further investigation will be needed to determine the causes of this variation, which is probably due to changes in temperature and hence viscosity. When

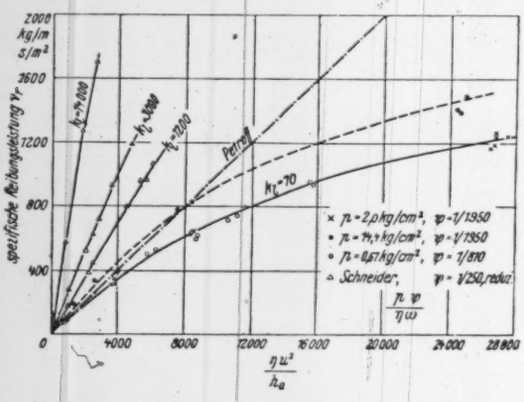

FIG. 4 SPECIFIC AMOUNT OF FRICTION ν_r OF A CYLINDRICAL SLIDING BEARING
(*Reduz* = reduced.)

the heat given up by cylindrical sliding bearings was measured with the air at rest and in motion the following coefficients of heat treansfer have been determined. In air at rest, from 7 to 10 kcal per sq m per hr per deg C difference, and from 19 to 25 kcal per sq m per hr per deg C difference for air in motion. This includes the entire external surface of the bearing, that is, shoulders, screws, and other parts. Such tests as have been made hitherto do not give enough information to permit the calculation of the oil consumption in a bearing.

In the discussion which followed the presentation of the paper, M. ten Bosch, of Zurich, criticized attempts to discredit the validity of the hydrodynamic theory of bearing lubrication. His calculations and test would indicate that where his theory did not give correct results, this was due to the unsatisfactory experimental apparatus. He called attention in this connection to the test carried out by Wolff in 1929, which, after having been properly checked, came into very good agreement with the hydrodynamic theory. (Paper by A. Wewerka, abstracted through *Zeitschrift des Vereines deutscher Ingenieure*, vol. 77, no. 43, October 28, 1933, pp. 1169–1170, 3 figs., *te*)

MACHINE-SHOP PRACTISE

Matrix Alloy in Tool and Die Making

REFERENCE has been made previously to the matrix alloy as used by the Westinghouse Elec. & Mfg. Co. (MECHANICAL ENGINEERING, vol. 54, no. 1, January, 1932, p. 52). During the last two or three years this method has been applied extensively in making dies, jigs, and fixtures in an effort at economy in costs. It is said that the use of matrix alloy eliminates many of the extremely close operations ordinarily required in tool and die making. It contains bismuth, lead, tin, and antimony, and melts at 248 F, with a pouring temperature generally about 350 F. The matrix alloy is poured into spaces that have been provided between the various parts that make up the die or other tool and is sufficiently hard and non-shrinkable to hold dies permanently in their proper location. Having a low melting point, the metal has no effect on the hardness of the die. It is claimed that accuracy is not sacrificed. The method of anchoring matrix alloy in place is described, and as an illustration of the process in the application of making punches and dies is described in detail. (J. R. Weaver, Works Equipment Engr., Westinghouse Elec. & Mfg. Co., in *Machinery*, New York, vol. 40, no. 3, November, 1933, pp. 129–132, 4 figs., *dp*)

MARINE ENGINEERING

North-Eastern Reheater Marine Steam Engine

THIS engine employs poppet valves in the high-pressure and medium-pressure cylinders which are disposed at both ends with a low-pressure cylinder in the center, where it has both thermal and mechanical advantages.

In this new design the temperature of steam entering the high-pressure cylinder is kept below 600 F, which, of course, is in accordance with what has been usual practise for some time. By means of the reheating arrangements, the steam at entry to the medium-pressure chest has a considerable amount of superheat, with a total temperature of more than 500 F instead of a very slight superheat as in the normal engine. The steam entering the low-pressure cylinder still retains a slight superheat. The reheater follows the usual tubular type of surface heater, the tubes being fixed at one end only, so as to avoid stresses due to expansion. The live steam is led from the boiler to the reheater, which it reaches at a temperature of 730 to 740 F. Here a certain amount of its heat is given up to the steam passing to the medium-pressure cylinder, and it is then brought to the high-pressure inlet valve, by an external pipe, at a temperature of about 600 F.

The steam generator follows accepted Scotch-boiler practise in its essentials but has been designed as a special superheater boiler instead of adding superheaters to a boiler designed for the production of saturated steam. To do this a particular form of fire-tube superheater has been developed, most suitable to attain high temperatures, and eliminating the disadvantage of choking up. The superheater element consists of a cage of three double heating elements disposed at the hotter end of the tube. The cage also contains a suitable retarder device for insuring efficient heat transfer from the gases. It is claimed that a temperature at superheater outlet of about 750 F can regularly be maintained. Tubes having a bore of $4^3/_4$ in. are used. The engine has been designed by a British company and has not yet been built. (*The Marine Engineer*, vol. 56, no. 670, July, 1933, p. 201, *d*)

Two-Stroke-Cycle Eight-Cylinder Marine Engine

THIS engine, which has been recently completed, has been built by John G. Kincaid & Co., Ltd., at Greenock, for the vessel *Malaita*. It is of the trunk type, has eight cylinders, and has been designed for a normal power in service of 1740 bph at about 110 rpm with a reserve continuous overload capacity of 2088 bhp. It incorporates the chief features of the Burmeister and Wain two-stroke engines, but has a trunk arrangement of the pistons and a different exhaust-valve drive. The exhaust valves are of the piston type, and are located at the top of the cylinders, so that there is a straight-through flow of the scavenge air from the bottom to the top of the cylinders. Effective scavenging is further insured by arranging the scavenge ports so as to give the inlet air a whirling motion, and the whole design is arranged with a view to insuring uniform cool-

ing and preventing distortion. The exhaust valves are timed to give a full charge of air at scavenge pressure after the cylinder has been thoroughly scavenged. The main crankshaft carries an eccentric on the forward side of each throw, the small ends of the eccentric rods being coupled to crossheads connecting the lower ends of large guide rods at the front and back of the main framing. These rods pass through long guides, and at their upper ends are connected by inclined rods to yokes in which the exhaust piston valves are mounted. It will thus be noticed that the drive for the valves differs from the usual one in that eccentrics on the main shaft take the place of the chain-driven auxiliary shaft. The stroke of the valves is about one-third that of the main pistons, and it may be observed in passing that as they are of relatively large size and are directly exposed to the gas pressure, they perform an appreciable amount of useful work on the upward stroke.

Details of the blowers are given in the original article. From the tests it would appear that the mechanical efficiency of the engine is 88.6 per cent. The oil consumed is 0.388 lb per bhp-hr and 0.345 lb per ihp-hr (mechanical efficiency and indicated horsepower have been worked out neglecting exhaust pistons). These figures have been taken from a test carried out in the manufacturer's plant. (*Engineering*, vol. 136, no. 3535, Oct. 13, 1933, pp. 410–411, 4 figs., *d*)

2000-Ihp Semi-Uniflow Marine Engine

THIS engine was installed by Alexander Stephen & Sons, Ltd., Glasgow, on the steamship *Annan*, 955 tons, as the vessel was reconditioned. This engine is said to represent a decided step forward in the design of reciprocating engines for marine use, the main effort having been directed toward obtaining the maximum economy possible in a reciprocating engine using high superheat and a good vacuum, but without the use of an exhaust turbine. This has been done by using compound expansion with a single steam receiver, made economical by the conditions of superheated-steam operation which are entirely different from those with saturated steam. The losses due to heat exchange with the walls of the cylinder are almost entirely absent in the former case, while both valves and steam ports remain at a constant temperature. The use of a single intermediate steam receiver reduces heat losses from this source, and because of the use of the uniflow principle in the low-pressure cylinders, there is little loss due to heat exchange in the cylinders.

The free exhaust through the ports of the cylinder walls, which open at about $^9/_{10}$ of the stroke, reduces the back pressure to within $^1/_2$ lb of the condenser pressure. From tests made on the *Annan* engine the reduction in steam consumption due to the use of the uniflow principle was found to be about 9 per cent on a corresponding cylinder, or about 3 per cent overall. The frame of the engine is built up of mild steel plates welded and riveted, producing a light but rigid structure.

One of the most striking features of the engine is the arrangement of the valve gear, hydraulically operated, and with independent steam and exhaust valves of the Andrews and Cameron type. These valves give a quadruple opening, and are balanced and free to expand under high temperatures while remaining steam tight. The high-pressure valves have a vertical travel and the low-pressure valves a horizontal travel. The spindles are of case-hardened steel ground and lapped, and work in long, cast-iron bushes with oil grooves and forced lubrication, thus eliminating the friction always present with the packed gland, as well as the possibility of oil leaking into the steam space. The use of independent valves makes it possible to select the best valve setting for inlet and cut-off, to be arranged without any bad effect on the point of compression. Coupled valves are employed for the high-pressure exhaust. The hydraulic valve gear for operating the valves is described in detail in the original article. It is claimed that it gives an early cut-off with quick opening and closing of the valves. The engine has recently been tested by Prof. A. L. Mellanby, of the Royal Technical College, Glasgow, and some preliminary results of these tests are given in a table in the article.

The consumption per brake horsepower-hour is given as 10.95 lb, equivalent to 9.52 lb of steam per indicated horsepower-hour on an engine with a mechanical efficiency of 90 per cent, which is the figure usually assumed on marine steam engines. The mechanical efficiency as shown by tests was, however, 95.9 per cent. (*Engineering*, vol. 136, no. 3538, Nov. 3, 1933, pp. 489–492, 12 figs., *d*)

Isherwood "Arcform" Ship Construction

VERY recently the first of three cargo ships built on the new Isherwood "arcform" design was launched. Some information about this design can be obtained from Fig. 5, this being about the only information thus far disclosed. The design is intended for freight vessels, particularly of the tramp type, and it is expected that it will show a saving in fuel consumption of from 25 to 50 per cent. These economies, moreover, are not being obtained by a paring down of the

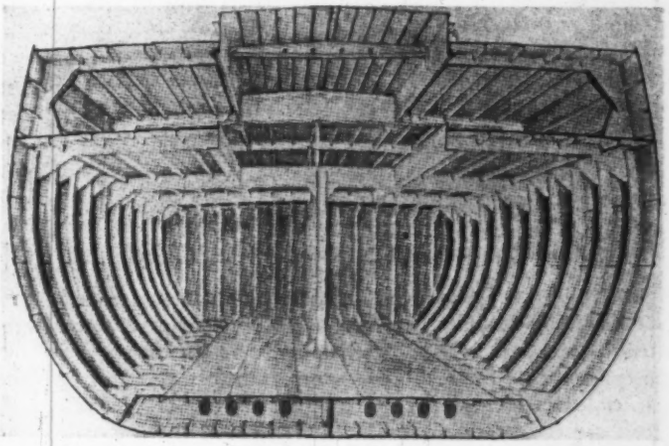

FIG. 5 PERSPECTIVE VIEW OF ISHERWOOD ARCFORM CONSTRUCTION

strength members of the hull, and it is even claimed that the arcform ships will be actually stronger than the ordinary design. The vessel is of 7000 tons dead weight and is equipped with two Scotch boilers with forced draft and one auxiliary boiler, all working at a pressure of 220 lb per sq in. Superheaters are fitted to the two main boilers to give a total of 630 F. It is estimated that these ships will steam 11 knots on 21 tons of coal a day, 10 knots on 16 tons, and 9 knots on $11^1/_2$ tons. Experiments at Teddington have shown that with certain modifications of the propeller design the fuel can be cut down by about one half ton per day.

Apparently Sir Joseph Isherwood has built the three ships himself in the expectation that by convincing the shipping community of the operating economies which these vessels can achieve, he will find buyers for them and generally introduce the design. Further experiments are being conducted

with the view to demonstrating the advantages of this form for vessels at higher speeds. Some of these tests are carried out up to about an equivalent of 35 knots. (*Shipbuilding and Shipping Record*, vol. 42, no. 18, Nov. 2, 1933, pp. 426–427, 2 figs., *dA*)

METALLURGY (See Machine-Shop Practise: Matrix Alloy in Tool and Die Making)

MOTOR-CAR ENGINEERING

Crossley Rear-Engine Streamlined Car

THIS was to be exhibited at the Olympia Automobile Show in London. In the Crossley car the objection that rear mounting of the power plant and streamlined housing led to excessive length has been overcome in part, as the car has a wheelbase of only 116 in. though an overall length of about 186 in. The engine is a six-cylinder design and is combined into a single unit with a clutch transmission and final drive. It is located back of the rear wheel axle, while the transmission is forward. Power is transmitted from the center of the flywheel by means of a cushioned driving member connected to the stem-wheel of the four-speed preselective transmission, at the rear end of which a double helical gear-set is enclosed. There is no rear-axle tube or rear-axle beam. Instead, there is an inner stationary hub at each end which is supported by a conventional half-elliptical spring. The radiator is located in its usual position at the front, and in order to assure adequate air circulation without a fan, an extractor effect is provided for by arranging outlets by means of valances in the mud guards. (*The Motor*, London, abstracted through *Automotive Industries*, vol. 69, no. 17, Oct. 21, 1933, pp. 478–479, 3 figs., *d*)

POWER-PLANT ENGINEERING

Sulzer High-Pressure Boiler Plant at Belgrade

ONLY certain features of this interesting plant are reported here. In placing the contract for the plant it was stipulated that the stokers must be able to burn Trifail coal with an ash content of 17 per cent, as well as lignite.

In order to prevent the deposit of flue dust on the water tubes, upright water-tube boilers were selected and the spaces between the tubes have been made larger than usual, so that the flue dust cannot accumulate between the tubes. Sulzer two-drum double-bank upright water-tube boilers were installed. The boiler system is suspended from the upper drum, while the lower drum, balanced by counterweights, is free to move up and down as the temperature rises. The stoker is of the mechanical traveling type with an inclined grate in which every second horizontal bar makes alternately a forward and a backward movement. The amount of travel can be adjusted to suit the different fuels. Air is led to the grate by induced draft through compartments under it, and the quantity of air can be regulated within wide limits in the different compartments. It has proved to be of a particular advantage that the grate can be set at various angles to the horizontal while working, since this adjustment enables combustion to be kept good with various fuels. The combustion air is preheated to about 170 C (338 F) in a rotating Ljungström air heater. (*Sulzer Technical Review*, no. 2, 1933, pp. 1–5. Compare *The Steam Engineer*, vol. 3, no. 2, November, 1933, pp. 61–62, 1 fig., *d*)

Trends in Turbine Engineering

THE author, manager of the Turbine Apparatus Division, Westinghouse Electric & Mfg. Co., presents a table giving equivalent costs of installation for differential overall efficiencies and for different ratios of load to capital parts of the cost. From this it would appear that if the load part and the fixed part stand in the ratio of 40 to 60, the efficiency at 28 per cent, a gain in overall efficiency from 28 to 40 per cent (43 per cent reduction in heat consumption) must not add more than 17 per cent to the cost of the installation in order to be justifiable from an economical point of view. It is safe to state that it must be considerably less than 17 per cent in order to make the venture sufficiently attractive.

This situation has injected a certain amount of hesitation in the advance toward higher pressures, at least as far as our own country is concerned. However, they must be used if efficiencies in excess of 30 per cent are to be realized, so that the question of reheat cannot be evaded.

The available information is insufficient to decide whether or not this solution will result in lower cost of power. There are boiler developments in the embryo stage, however, which may upset this condition entirely. The forced-circulation type of boiler, without drums, has advanced very rapidly in Europe during the last few years. With this type of boiler it is well within the realm of possibilities so to design the entire power generation plant unit that the principal objections to reheating are eliminated. This would raise the practical operating pressures to the critical pressure (3200 lb per sq in.) and above. A development of such a fundamental nature can only come slowly, however. In the meantime the industry is endeavoring to solve its problems in the best possible manner, using equipment which does not go too far beyond the conventional.

Apart from a rise in the inlet temperature, the author considers the superposition of high-pressure equipment on existing low-pressure turbines as a solution which is bound to play a very important rôle in the future, and considers a combination of power and steam generation for heating purposes as perhaps the most important feature of all in recent power developments.

He next considers the factors retarding efficiency improvement. The basic efficiency of a reaction stage with great blade heights can probably be brought as high as above 95 per cent. The discrepancy between this value and the present value of turbine efficiency of from 70 to 85 per cent is often a surprise to the purchaser of steam turbines. The author lists the principal sources of loss which cause the discrepancy and analyzes them. He then proceeds to the analysis of flow disturbances in the blade path. One of the most difficult problems in the design of steam turbines is to give the control system the necessary sensitivity, freedom from oscillations, and reliability. Although the most common type of speed-responsive element is still the flyball type, the fluid type (centrifugal oil pump) appears very logical, since valve operating gears are almost universally of the hydraulic type. Recent developments have led to a construction in which the main oil pump, mounted on the main turbine shaft and having no special pressure characteristics, is connected to a pressure transformer which magnifies and reverses the comparatively weak impulses from the impeller. The magnified impulses are transmitted to the relays of the valve-operating mechanisms, arranged as servo-motors. The scheme permits the use of separate fluids for governing and lubrication.

Where the control system must respond to changes of back pressure, as well as to changes of speed, it is necessary to translate back-pressure impulses into the same currency as the speed changes. This is easily done by admitting oil at a pressure, dependent upon the back pressure, on the opposite side of the

primary transformer diaphragm. Given the correct ratios of pressures, a rise in back pressure will be synonymous with a rise in speed; that is, both events will cause the governor valve to close. (Address by C. Richard Soderberg before the National Association of Power Engineers, abstracted through *Electrical World*, vol. 102, no. 16, Oct. 14, 1933, pp. 501–502, *g*)

PUMPS

Air Required by Air-Lift Pumps

THE author derives the following formula for the number of cubic feet of free air required to raise one gallon of liquid through a distance of h ft:

$$V_T = \frac{h}{255 \log_e \frac{p_1}{p_2}}$$

where p_1 is the absolute submergence pressure (gage + p_2) and p_2 is the atmospheric pressure, 14.73 lb per sq in.

For more convenient handling this is changed to the common logarithmic base and becomes

$$V_T = \frac{h}{(255)(2.3026) \log_{10} \frac{p_1}{p_2}} = \frac{h}{587 \log_{10} \frac{p_1}{p_2}}$$

Taking H ft as the submergence of the air inlet and substituting for the pressures p_1 and p_2 their equivalent water heads in feet, the equation takes the familiar form of

$$V_T = \frac{h}{587 \log \frac{H + 34}{34}}$$

This is the base formula for computing the cubic feet of free air required to raise one gallon of water a distance of h ft, with a submergence of H, and represents an installation of 100 per cent efficiency at sea level. It is readily seen that this can be changed so as to apply to any liquid by substituting the actual weight per gallon and the equivalent heads for p_1 and p_2.

As is the case with any type of pump, an efficiency of 100 per cent is unattainable. The coefficient 587 is usually called C, and various values are assigned to it, which represent the expected efficiency in percentage. That is, if C were 293, the pumping efficiency would be 50 per cent. (Francis Bates in *Civil Engineering*, vol. 3, no. 11, November, 1933, pp. 626–627, *p*)

RAILROAD ENGINEERING

Diesel Traction

PROF. G. LOMONOSSOFF tells how, after agreeing to cooperate in Diesel-locomotive development, the German and Russian railways decided some years ago to build four locomotives with mechanical, electrical, hydraulic, and pneumatic transmissions. The locomotive with electric transmission has now covered more than 330,000 miles on Russian railways. The one with mechanical transmission, though imperfect in some respects, has run about 200,000 miles in Russia. The locomotive with hydraulic transmission has proved to be impracticable on account of the low volumetric efficiency under heavy loads, and increasing viscosity of the oil and tightening the packings have both proved impracticable as ways of improving this. The locomotive with pneumatic transmission was not completed until 1930 and required the introduction of several protective processes entailing complications which further investigations had not been very successful in overcoming. The lecturer thought, however, that partial pneumatic transmission, i.e., the use of air or hydraulic clutches for starting, was a possible future development.

He then analyzed in detail the various items of cost of operation in steam and Diesel traction and came to the conclusion that the future of Diesel traction depends mainly on the initial price of the locomotives. Electric transmission provides the greatest degree of flexibility, but is so expensive, heavy, and complex that the lecturer could not regard it as the final standard for Diesel locomotives. Economically, the Diesel geared locomotive is a more satisfactory unit than the technically more correct Diesel electric locomotive. He considered the multi-speed gear box of the automobile type unsuitable for outputs above 500 hp and a single-speed locomotive having an engine of 1.78 times the normal power with a hydraulic clutch was proposed as a possible alternative to existing designs. Given an engine of sufficient flexibility, such a locomotive would perform the same duties as one with electric transmission but with several gears, and it would be both cheaper in first cost than the Diesel electric locomotive and easier to maintain. (Paper before the Institution of Mechanical Engineers, at Manchester, abstracted through *Diesel Railway Traction*, supplement to *The Railway Gazette*, Oct. 6, 1933, pp. 501–503, 3 figs., *d*)

"Railmobile"

THIS is a new vehicle developed jointly by Fairbanks, Morse & Co., the Goodyear Tire & Rubber Co., and the Chrysler Corporation. It is claimed that one of the essential differences between automotive vehicles and standard railroad

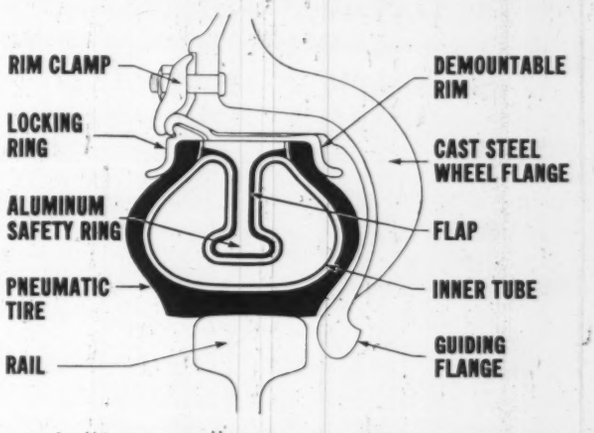

FIG. 6 "RAILMOBILE" TIRE WITH ALUMINUM SAFETY RING

vehicles lies in the type of axle. Railroad equipment employs a solid type of axle in which the whole assembly of axle and wheels turn. Automotive equipment employs a stub axle for the front wheels and a rear axle divided at the differential. It is said that attempts to use flanged steel wheels on the automotive type of equipment proved that stub axles could not stand up under such service without fracture of the material. Steel wheels could not safely be used on automotive type of equipment without such extended redesign that the advantages of standardized low-priced automotive vehicles would be lost. Because of this, pneumatic tires to solve material fatigue problem of the stub axle were studied and it is claimed that finally

a wheel was developed using a high-pressure pneumatic tire with an aluminum alloy "safety ring" screwed to the wheel rim and located within the tire to help in the dissipation of heat. Moreover, as the safety ring is placed within $^5/_8$ in. of the inner surface of the casing tread, it prevents the vehicle from leaving the rail in case of a blowout or puncture. (Abstracted from a mimeographed circular, illustrated, *d*)

Modern Trends in Railway Motive Power

THIS is a general and profusely illustrated discussion of the subject. One illustration shows the status of competition with the railroad in 1905, the competitors being a trolley car and a horse-drawn wagon. By 1933 there had been added the private automobile, the bus, the truck with its trailer, the airplane, the barge line, and the pipe line. Railroads are still, however, handling by far the greater bulk of freight traffic.

As regards the motive power proper, Fig. 7 shows a proposed high-capacity type of locomotive with low individual piston thrust. It is a machine that would give a tractive force of a non-articulated locomotive of exceptional size, but its piston thrust would be reduced about 50 per cent with corresponding reductions in size of products and with the possibility of some reduction in upkeep expense. It would be suitable for heavy high-speed freight service, or for heavy moderate-speed passenger trains over sections having severe profiles.

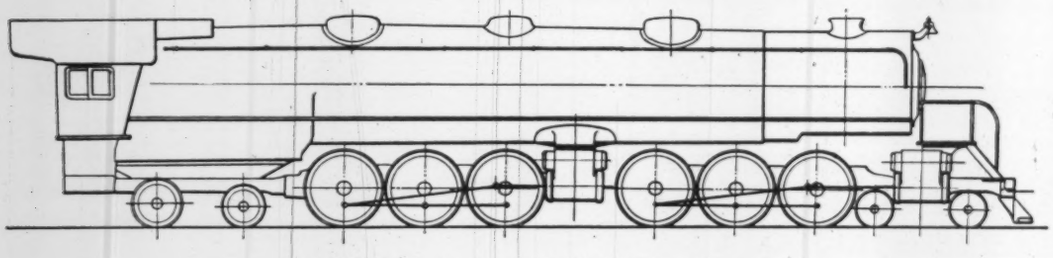

FIG. 7 PROPOSED DESIGN OF LOCOMOTIVE FOR HEAVY SERVICE

One of the simplest designs and likewise one of the least expensive in the high-thermal-efficiency class is the locomotive developed and placed in service recently by the Baltimore & Ohio Railroad. A proposed design of local light passenger steam locomotive is also shown in the original paper.

Comparative performance characteristics of steam and Diesel locomotives are shown in curves in the original article. The Diesel has the advantage in starting pull, because of its uniform torque; its drawbar pull, however, drops very quickly. In the case of a steam locomotive the drawbar pull remains practically constant up to about 9 mph and then drops at a very much slower rate than the Diesel. The steam locomotive also has the disadvantage of a tender weighing from 50 to 70 tons which it must carry along at all times; and it must stop occasionally for replenishment of its water supply. The Diesel, on the other hand, is a self-contained unit with all of its weight on the driving wheels and with sufficient fuel and cooling-water capacity to permit it to operate more than 48 hours continuously. The bulk of the Diesel locomotives in operation are doing switching work, and while there may be at this time only little justification for a Diesel locomotive of high horsepower, there is much interest in this subject. The author illustrates a design of 2000-hp locomotive for passenger or freight service. It has two six-cylinder engines, each of 1000 hp, two generators, and a motor drive. No unit of this size has yet been constructed in this country, although a double unit of a total of 2600 hp has been constructed and placed in service on the Canadian National Railways. The author believes that there is more than a possibility that there will be a definite field for a locomotive of this type a little later.

Foreign experience with Diesel drives other than electric has been sufficiently satisfactory to indicate that an attempt may be made shortly to experiment with some form of drive other than the electric, particularly having in mind road service.

The author criticizes some of the features of present express Pullman-train operation. He claims that steam motive power can meet the issue of speed and can do it more economically if car weights can be substantially reduced, and shows the design of a streamlined steam locomotive, adding that "we may not like the appearance but we are going to like it—since the new lines will gain enough to make them worthwhile." The design shows a streamlined Hudson-type locomotive. The machinery parts are accessible, but the exterior has been smoothed out to avoid air pockets and otherwise arranged to permit a full and unrestricted flow of air. An illustration on the frontispiece shows a design of a streamlined steam locomotive and train for heavy, fast passenger service.

By way of conclusion the author calls attention to the unusually high motive-power expenses that prevailed during the past seven or eight years. Moreover, there is a large and growing demand for high-speed freight service which can be met economically and effectively only with motive power having adequate boiler and engine capacity and large driving wheels. Practically none of the locomotives built more than ten years ago are competent to perform this service, while some of the locomotives today are little better than museum pieces. (Wm. C. Dickerman, President, American Locomotive Co., address before the New York Railroad Club, Apr. 21, 1933, abstracted from a reprint issued by the American Locomotive Co., 1933, *dh*)

A "Diesel Boiler"

THE A. B. Götaverken, Gothenburg, Sweden, have developed a propulsion system for locomotives wherein a non-condensing type of turbine is used, the turbine being operated by the products of combustion from a Diesel engine or engines. The steam generator is replaced by a Diesel generator which consists of combustion cylinders and a direct-coupled compressor designed similarly to a heavy oil engine but with the difference that it works against a back pressure of the exhaust gases. Also, all the work generated in the combustion cylinders is expended in compressing air which is used partly in the combustion cylinders to dilute the exhaust gases from the generator in order to cool this down to a temperature suitable for a non-cooled propulsion unit. If the generator is a two-stroke engine, the whole mass of compressed air may be, with advantage, passed through the combustion cylinders. The Diesel generator therefore becomes virtually a "Diesel boiler."

The original article describing the device in detail shows a drawing of a two-cylinder unit with a single-cylinder scavenge pump and this actually represents an engine with an output of 300 bhp used on a tug which has been running for two years in Gothenburg harbor. Similar installation has been made on a turbine locomotive at the plant of Nydquist and Holm. Here

the control of the whole system is at the fuel pumps of the Diesel boiler. This has a great deal to recommend it, because it makes the turbine integral with the whole plant and eliminates any necessity for receivers of the gas under pressure, which again means economy of space in a locomotive. The Diesel boiler in this case has been built up on an old Diesel chassis and delivers gas sufficient for 500 bhp, in place of the 300 bhp of the old Diesel engine. It should be understood that this locomotive is purely experimental, and so far has only been running on test with the driving wheels coupled up to a brake.

The locomotive chassis is actually standing on jacks in the shops, and this means that the vibration from the Diesel boiler strikes one as rather excessive at first, but would not have anything like the same effect were the engine on rails. The locomotive is a square box-like structure and is a 1-B-1 unit, the driving wheels actually being the center of the two pairs of wheels which are coupled together by the usual side rods. The Diesel boiler is arranged fore and aft and the turbine is placed transversely, the drive to the wheels being by means of suitable reduction gearing. No information as to efficiencies or fuel consumption is given in the original article. (A. C. Hardy, in *Diesel Railway Traction*, supplement to *The Railway Gazette*, Oct. 6, 1933, pp. 504–505, 1 fig., *d*)

REFRIGERATION

Oil for Refrigeration

THIS has been tried out as a substitute for brine by the Hayden Ice Cream Co., because it had experienced considerable difficulty from disintegration of brine tanks as a result of the electrolytic action of the brine.

After a preliminary estimate of the problem, an oil used in the motion-picture industry and known as "hydraulic circulating oil" for operating small turbines was suggested. One cabinet was operated with it for several months in an entirely satisfactory manner.

The specific heat of this oil is 0.445 at 0 F as compared with about 0.70 for calcium chloride; because of the lower specific heat, with the same control settings, operating cycles are somewhat more frequent. The oil has a flash point of over 260 F, its viscosity is about 65 sec at 100 F, and the specific gravity is 0.85 to 0.87.

After another dairy had commenced to use the oil in quantities, the San Francisco laboratory of the Standard Oil Co. carried out some experimental work which confirmed the good results obtained with the initial installation. It was found, however, that on very long cabinets, where the chilling unit was located in the center, slightly more than the normal temperature difference was noted between the middle and ends of the cabinet. This was evidently due to the fact that the viscosity of the oil increased with lowered temperatures, and circulation became somewhat retarded. Now, only a few months after the first tests were made, the new oil is being specified for marine brine-tank installations.

The oil is made from emulsion-proof stock, and is absolutely proof against electrolytic action, permitting the use of soldered galvanized tanks. A request was received for a quotation on 40,000 gal for an ice-plant installation, but there were several difficulties yet to be overcome. First, water overflow in ice-plant work would settle to the bottom and freeze, while removal of the ice cans from the oil would spread the oil over the floors, making them extremely slippery. However, it would be suitable for brine circulating systems, for the temperatures are not so low as to increase viscosity too much. The laboratory is still experimenting with this special oil, and certain improvements may shortly be incorporated in the product. (E. S. Herman, paper presented at a meeting of the Los Angeles Section of the American Society of Refrigerating Engineers, abstracted through *Cold Storage*, vol. 36, no. 427, Oct. 19, 1933, p. 232, *e*)

SPECIAL APPARATUS

An Electric Sieve

THIS is used for the separation of materials substantially in the same way as mechanical sieves, except that the apparatus is good for handling grains of electrically non-conductive materials up to 2 mm (0.078 in.) in diameter. It consists of a vertical shell with several outlets located at different heights, an orifice in the bottom which may be closed by a valve, and a hopper at the top, this hopper being movable back and forth bringing it nearer to or further away from the orifices. A charge of some 50,000 volts is imposed on the material.

The operation of this device is based on the following: As the material falls through the hopper it is attracted electrically by the shell; the smallest particles moving faster than the others reach the outlet first, and therefore go through the top outlet. The next larger particles fall a little longer way and go through the next outlet, etc. Certain precautions are taken to prevent the largest particles from carrying through with them a certain proportion of the small particles. The original article shows diagrammatically the device and the circuit employed. (*Chemiker Zeitung*, vol. 57, no. 69, Aug. 30, 1933, pp. 682–683, 2 figs., *d*)

SPECIAL PROCESSES

Roll-Forge Process for Making Concentric Sections

IN THE machine used in this process the stock (round or square bars heated to rolling temperature) is reduced and formed as it passes between two formed rolls and at the same time is rolled in a transverse direction in much the same manner as a pencil is rolled between the palms of the hands. The top and bottom rolls are identical and are formed by straight cutting across the entire roll face. In operation they are registered from the keyways and are synchronized so that the cut formed in the upper roll matches the cut in the lower roll. The two rolls, however, are made to oscillate on their axes; as the upper roll moves to the right, the lower one moves to the left. The oscillating action operates simultaneously with the forward feeding, and because of this arrangement a bar being roll-forged is essentially rolled in two directions at the same time. Thereby, the product becomes concentric and is made to conform to the cross-section which is embodied in the roll faces. Further details are given in the original article. The process produces no flash and it is claimed that all forms of concentric shapes can be produced and that an unusually wide variety of the regular shapes can be produced from these concentric blanks. (*Steel*, vol. 93, no. 21, Nov. 20, 1933, pp. 26, 3 figs., *d*)

Limitations of X-Ray Inspection

IN PIPING for steam at 600 lb pressure and 850 F temperature, the operator demands assurance of safety, and to give him that in welded piping, X-ray inspection of welds is frequently made. But although the X-ray will reveal inclusions and defects of metallic structure in a weld, it will not clearly

show, nor in all cases even indicate, places where surfaces are merely in close contact and not fused together. The limitation of X-ray inspection was brought to the fore by A. S. Douglass, Detroit Edison Company, who said that in none of the test welds which were sent to three different laboratories for radiographs was the lack of fusion between contacting surfaces detected. In discussion of this paper it was stated that gamma rays were more effective than X-rays in revealing this condition, and also that a condition of porosity in one and not in the other of the contacting surfaces was good grounds for suspicion that the surfaces were not joined. (A. S. Douglass in a paper before the American Welding Society and several other organizations, held in Detroit, in October, 1933, abstracted through *Electrical World*, vol. 102, no. 16, Oct. 14, 1933, p. 486, *p*)

STEAM ENGINEERING (See also Marine Engineering: 2000-Ihp Semi-Uniflow Marine Engine; Railroad Engineering: A "Diesel Boiler")

Stephen Compound Marine Steam Engine

THIS is a three-cylinder compound-expansion reciprocating engine having one high-pressure and two low-pressure cylinders and a single steam receiver. The low-pressure cylinders are of the uniflow type. The engine is designed to work with steam at high superheat and with high vacuum, the object having been to produce a reciprocating engine which, under these conditions, will give maximum economy of steam consumption without the added complication of an exhaust steam turbine. A photograph of a 2000-ihp experimental unit is shown in the original article.

The valve operating gear is of the hydraulic type. An independent pump delivers oil at high pressure to a rotary distributor which is driven through gearing from the engine shaft. In the distributor are a number of ports which allow the oil pressure to be transmitted to small pistons on the ends of the various valve spindles. Variation in the point of cut-off and correction for lag in the system are obtained by sloping the ports in the casing of the distributor at an angle to the axis. Reversal is obtained by a second series of ports. It is said that the design has resulted in an engine for which the savings in weight and length with an average triple-expansion engine are estimated at 20 per cent. (*The Shipbuilder and Marine Engine Builder*, vol. 40, no. 283, October, 1933, p. 455, *d*)

THERMODYNAMICS

Calculation of Radiation From Gas Chambers

THE knowledge of radiation from gases is necessary for the design of combustion chambers. Experimentally, the determination of heat transfer by radiation is complicated and tedious in that it requires difficult integration. Such computations, however, have been carried out by W. Nusselt, for the cases of a sphere and an infinitely long cylinder, and by M. Jakob for the case of an infinitely extending flat layer. Only for the case of the sphere has a closed expression been obtained, while for the case of an infinitely extending layer it is necessary to perform a simple integration made possible only by approximative methods, and for the case of an infinitely long cylinder a double integration of the same character is required.

The author of the article under review proposes a method for the calculation of the radiation of a volume of gas in the shape of a cylinder of any desired height or any desired diameter reduced to the computation of the case of an element of surface in the middle of its base and resulting in a closed integration. With this solution it is possible to compute the radiation from a volume of gas limited by surfaces with straight edges and reduced to the computation of any element of the surface limiting the gaseous shape. Moreover, this can be done by a simple integration according to well-known processes of approximation.

If a gas space radiates (through the presence therein of carbon dioxide, water vapor, or soot) to a surface, each element of that surface receives radiation from all directions, and the intensity of the radiation depends on the thickness of the layer of gas which must be passed in that direction. The author designates the ratio of emission by ϵ, this being the ratio between the radiation from a gas and the radiation from an absolutely black body maintained at the same temperature; ϵ depends on the shape of the radiating body and the direction of radiation. The black body of gas temperature T_g radiates toward an element of surface having a temperature T_0 in accordance with the Stefan-Boltzmann law determining its intensity.

$$E_s = C_s \left[\left(\frac{T_g}{100} \right)^4 - \left(\frac{T_0}{100} \right)^4 \right] \quad [1]$$

where $C_s = 4.96$ kcal per sq m per hr per (deg abs difference of temperature)^4, and is the coefficient of radiation of an absolutely black body. According to this the energy radiated from the gas to an element of surface df is

$$dW = df \frac{E_s}{\pi} \int_{\varphi=0}^{\pi/2} \int_{\psi=0}^{2\pi} \epsilon \cos \varphi \sin \varphi d\varphi d\psi \quad [2]$$

where as shown in Fig. 8 φ is the angle of direction of radiation with the normal of df, ψ is the azimuth, and $\sin \varphi d\varphi d\psi$ is an element of the solid angle. If the space occupied by the gas has the shape of a body of rotation, it can be integrated in ψ, thereby obtaining

$$dW = df E_s \times 2 \int_0^{\pi/2} \epsilon \cos \varphi \sin \varphi d\varphi \quad [2a]$$

The calculation of the total radiation amounts then to the evaluation of the integral

$$\epsilon_g = 2 \int_0^{\pi/2} \epsilon \cos \varphi \sin \varphi d\varphi \quad [3]$$

and this may be designated as the ratio of emission of the

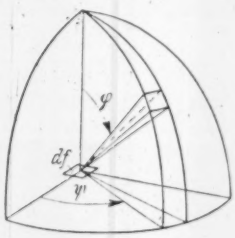

Fig. 8

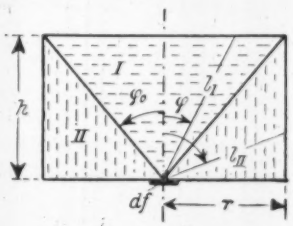

Fig. 9

FIG. 8 DIAGRAM SHOWING DIRECTION OF RADIATION FROM AN ELEMENT OF SURFACE df

FIG. 9 DIVISION OF A CYLINDRICAL GASEOUS SPACE INTO TWO PARTS, I AND II

gaseous space in respect to the element of surface df. For a gas with a constant coefficient of absorption a

$$\epsilon = 1 - e^{-al} \quad \ldots\ldots [4]$$

where l is the path traveled by the ray in the gas.

In order to compute the radiation of a cylindrical gas space of height h and radius r to an element of surface in the middle of the base of the cylinder, the cylinder as shown in Fig. 9 is divided by means of a cone of half its included angle φ_0 into the two parts, I and II, denoted by different cross-sectioning. The ratio of emission can then be divided between the two parts in accordance with equation

$$\epsilon_\varphi = \epsilon_{\varphi I} + \epsilon_{\varphi II} \quad \ldots\ldots [5]$$

In part I the path traveled by the ray is $l_I = h/\cos\varphi$, and in part II, $l_{II} = r/\sin\varphi$, and hence

$$\left.\begin{aligned} \epsilon_{\varphi I} &= 2\int_0^{\varphi_0}\left(1 - e^{\frac{-ah}{\cos\varphi}}\right)\cos\varphi\sin\varphi d\varphi \\ \epsilon_{\varphi II} &= 2\int_0^{\varphi_0}\left(1 - e^{\frac{-ar}{\sin\varphi}}\right)\cos\varphi\sin\varphi d\varphi \end{aligned}\right\} \quad \ldots\ldots [6]$$

Both of these integrals can be evaluated in a closed form by the use of the so-called integral logarithm

$$Ei(-z) = \int_\infty^z \frac{e^{-x}}{x}\,dx \quad \ldots\ldots [7]$$

a transcendent function for which tables of numerical values are available. If we write

$$\epsilon_{\varphi I} = \sin^2\varphi_0 + \int_0^{\varphi_0} 2e^{\frac{-ah}{\cos\varphi}}\cos\varphi d(\cos\varphi)$$

then introduce a new variable under the sign of the integral, namely, $z = ah/\cos\varphi$, and carry out a partial integration, we obtain from the integral of the preceding expression

$$-2(ah)^2\int_{ah}^{\frac{ah}{\cos\varphi_0}}\frac{e^{-z}}{z^3}\,dz = (ah)^2\left[\frac{e^{-z}}{z^2} - \frac{e^{-z}}{z} - Ei(-z)\right]_{ah}^{\frac{ah}{\cos\varphi_0}}$$

and from this

$$\epsilon_\varphi = \sin^2\varphi_0 + (ah)^2\left[\frac{e^{-z}}{z^2} - \frac{e^{-z}}{z} - Ei(-z)\right]_{ah}^{\frac{ah}{\cos\varphi_0}} \quad \ldots [8]$$

For the sake of abridging the equation, the following function is introduced:

$$\Phi(z) = e^{-z} - ze^{-z} - z^2Ei(-z) \quad \ldots\ldots [8']$$

and this permits us to write

$$\epsilon_{\varphi I} = \sin^2\varphi_0 - \Phi(ah) + \cos^2\varphi_0\,\Phi\left(\frac{ah}{\cos\varphi_0}\right) \quad \ldots [8a]$$

Correspondingly, we obtain

$$\epsilon_{\varphi II} = \cos^2\varphi_0 - \Phi(ar) + \sin^2\varphi_0\,\Phi\left(\frac{ar}{\sin\varphi_0}\right) \quad \ldots [b8]$$

and here, as one can easily see

$$\frac{h}{\cos\varphi_0} = \frac{r}{\sin\varphi_0} = \sqrt{(h^2 + r^2)}$$

which is the diagonal in the rectangle having sides h and r, which is the longest path of radiation travel.

For the total ratio of emission from a gas cylinder to an element of a surface in the middle of its floor space, the following amazingly simple expression is obtained

$$\epsilon_\varphi = \epsilon_{\varphi I} + \epsilon_{\varphi II} = 1 - \Phi(ah) - \Phi(ar) + \Phi[a\sqrt{(h^2 + r^2)}] \quad \ldots [9]$$

To facilitate its practical application, values for the function $\Phi(z)$ have been given in Table I in the original article.

Equation [9] makes it possible to deal with the case of an infinitely extended layer of gas of thickness h, r being permitted to become infinitely great. This makes the two terminal-members disappear completely and the only thing that remains is

$$\epsilon_\varphi = 1 - \Phi(ah) \quad \ldots\ldots [9a]$$

This function is shown in Fig. 10 by the topmost curve and agrees throughout with the data for a few points obtained

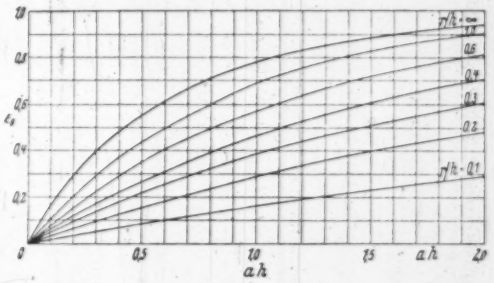

FIG. 10 TOTAL RATIO OF EMISSION ϵ_φ OF A GAS CYLINDER WITH RESPECT TO A SURFACE ELEMENT IN THE MIDDLE OF THE BASE (h = height; r = radius; a = coefficient of absorption.)

from an approximative process by Jakob. However, with r constant and the height h of the cylinder infinitely large, then in Equation [9] the second and last members disappear and all that remains is

$$\epsilon_\varphi = 1 - \Phi(ar) \quad \ldots\ldots [9b]$$

From this it would appear that an infinitely extended plane layer of gas of height h radiates in its region with the same intensity that an infinitely tall cylindrical layer of gas with radius r radiates to the middle of its ground area.

Fig. 10 shows the emissivity as a function of ah for a cylinder with various values of r/h. Since Equation [9] is symmetrical in h and r, the radiation of a cylinder of height h and radius r to the middle of its ground area is exactly as great as one from a cylinder of height r and radius h.

From this the author proceeds to the determination of radiation in spaces with straight-line edges and obtains the equation for the emissivity in such a case. He also gives curves for the emissivity of water vapor as a function of the temperature and the thickness of the layer of the vapor, this being applicable to the case of radiation in a combustion chamber. This part cannot be abstracted because of lack of space. (Dr.-Ing. Ernst Schmidt in *Zeitschrift des Vereines deutscher Ingenieure*, vol. 77, no. 43, Oct. 28, 1933, pp. 1162–1164, 6 figs., *tmA*)

VARIA

Avoidable Waste in Engineering Processes

AN EDITORIAL in *Engineering* discusses the above subject in the light of the presidential address given by C. R. F. Engelbach to the Institution of Automobile Engineers, in London, early in October.

Dealing with the actual conditions ruling in the Austin works at the present time, he pointed out that in order to produce

finished products of a total weight of 33,762 tons, no less than 146,046 tons of material were required, made up of 68,777 tons of productive material, 14,112 tons of consumable stores, and 63,157 tons of coal and other fuel. In other words, 26 per cent of the total materials received in the works was delivered to customers, and 74 per cent was consumed or wasted in various processes.

There are only incidental references in Mr. Engelbach's address to the possible waste of material in preparing the raw products of the engineering industry, such as the fact that to produce 170 tons of finished castings, 1000 tons of iron ore, 600 tons of coal, and 200 tons of limestone are employed, while 1000 tons of iron ore, 610 tons of coal, and 200 tons of limestone are used up in making 124 tons of stampings.

Dealing first with the foundry, it is pointed out that in the Austin works, 276 tons of pig iron are required to produce 170 tons of castings, irrespective of the coke and other ingredients used in their manufacture. There are actually three directions in which it might be possible to reduce waste in this part of the works—closer control of the mix, the elimination of wasters by more accurate molding, and a reduction in scrap metal and machining times by finer machinery allowances. Whether appreciable economies are possible in any of these directions must be left to the foundry specialist, but it will be generally admitted that there have been no developments in foundry plant comparable with those in machine tools.

The stamp shop presents a somewhat similar case, in that little attention is given to the reduction of material wasted in flash and tag ends, or in the draw to enable the pieces to be removed from the dies. In the case of the press shop, it is usual to regard from 35 per cent to 40 per cent waste as a satisfactory percentage, only 3 to 5 per cent of this being due to faulty work. The conversion of this waste to pounds sterling results in a striking figure in the case of the Austin works. Some 16,000 tons of sheet metal are used annually, the average price being about £20 per ton, so that the yearly bill is approximately £320,000. Of this total material, some 35 per cent is scrap, representing £112,000, with a recovery value of £7000. The total dead loss on this material is, therefore, £105,000 per annum. (Editorial in *Engineering*, vol. 136, no. 3535, Oct. 13, 1933, pp. 415–416, *gA*)

Observations in British Machine Shops

THIS is based on the observations of a special correspondent rambling through British shops. Among other things, the author mentions a big wheel lathe fully electric-push-button controlled designed to turn out 36 pairs of wheels in and 8½-hr day, built at the plant of Craven Bros., in Manchester. The firm is equipping a plant for the Soviets in the Urals to turn out 300,000 pairs of railway wheels per year. The author mentions incidentally that on the machines built by that firm for the Soviets the name of the builders is marked in Russian letters only.

Twenty-six small shunting locomotives for Russia occupy the floor at Beyer-Peacock Co. This company has also built for Russia the largest Garratt locomotive, weighing 266 metric tons and being 110 ft long. It was slated to undergo its tests during the past summer.

As an interesting incident in his trip through British shops, the correspondent mentions the first Diesel engine built in England, in 1897, and now standing at the works of Mirrlees-Bickerton and Day. The first Diesel engine ever built caused trouble. The second, built in Augsburg, operated well, and the one at the Mirrlees shops is the third Diesel ever built. It is still running and is used to fill from its compressor the air bottles of engines prepared for shipment. (Willson Woodside, University of Toronto, in *Canadian Machinery and Manufacturing News*, vol. 44, no. 6, June, 1933, pp. 17 and 36, *g*)

WELDING

New Method of Welding Seams

THE German General Electric Company (A.E.G.) has evolved a welding method which it calls the modulation process. For the mechanically driven current interrupter is substituted a modulator which is essentially a single-phase induction regulator which is connected in auto-transformer connection to the network, and, according to the position of its rotor, increases or reduces the voltage impressed on the welding machine. The diagram of connections is shown in the original article. When the modulator is set into rotation, the root-mean-square value of the voltage across the welding

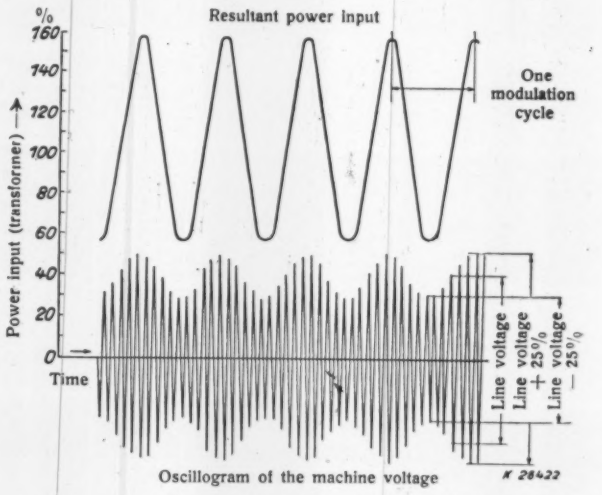

FIG. 11 OSCILLOGRAM OF THE WELDING MACHINE VOLTAGE AND POWER INPUT OF A MODULATION SEAM-WELDING MACHINE

machine fluctuates from normal to maximum and down again to minimum. Independent of this the line frequency remains engaged, and only the amplitudes of the line voltage alter periodically in synchronism with the modulator.

Fig. 11 (bottom curve) shows the oscillogram of the voltage supplied to the machine. When the modulator has one pair of poles, one revolution is equivalent to one cycle of modulation. The speed of the modulator per second is shown as the modulation frequency. The top curve of Fig. 11 represents the alteration of the input (transformer) at the modulation amplitude assumed.

An illustration in the original article shows the results of welding experiments carried with the new process. The varying distance between the spots on the three specimens shown were obtained by altering the speed of the modulator and show how a tight seam or a seam with excessive modulation is obtained. It is claimed that one of the seams proves that when two seams intersect each other the plate is not burned as would be the case without modulation. Another illustration in the original article shows a radiator unit welded by the modulation process. A number of claims for the new process are made in the original article, among them being that it is now possible to use seam welding in fields hitherto reserved for spot welding and that welds produced by the modulation process are scarcely distorted by heat. (*A.E.G. Progress*, vol. 1933, no. 3, pp. 50–51, 6 figs., *d*)

SYNOPSES OF A.S.M.E. PAPERS

(Available Upon Request)

COPIES of the papers and reports abstracted on this and the following page may, until the supply is exhausted, be obtained free of charge by members of the A.S.M.E., by addressing the Secretary, 29 West 39th Street, New York, N. Y. A charge is made to non-members. Where papers are not numbered, please mention authors' names in ordering copies.

AERONAUTICAL ENGINEERING

National Air-Tour Formulas and Other Methods of Handicapping. Methods of scoring and handicap used in aircraft competition events are given. The first part contains an historical review, and the second contains criticism of handicap formulas, these having a bearing on aircraft design and the improvement of airplanes. In many cases airplanes are especially designed for air races, and if the design is good, it increases progress. The paper takes up the formulas for handicapping and considers them from a race and design point of view. Useful curves are plotted. (Paper No. AER-55-14, by P. Altman.)

Mechanical Equipment for Handling Large Rigid Airships. The paper describes the development of the equipment used at the Naval Air Station at Lakehurst, N. J., for docking and undocking the U. S. S. *Akron*. The main feature of the plan is a stern handling beam or long horizontal girder lying athwartship beneath the stern of the airship, holding the ship from each side with a cable system from heavy trucks moving along outward-lying tracks, and a floating support resting on a castoring taxying wheel and placed under the reinforced lower fin. This stern handling beam moves out of the hangar following the mobile mast to which the airship is moored. When a circular track is reached, the airship is positioned in the proper wind direction. (Paper No. AER-55-15, by C. M. Bolster.)

The Economics of Air Transport. In this up-to-date analysis of the economic problems of aerial transportation, the author presents a revision of the basic formula for calculating the net cost of air transport, gives examples of its application, and discusses the following problems: (*a*) Application to a simple case; (*b*) the importance of overhead expense; (*c*) the influence of speed on net cost; and (*d*) flight at high altitudes. (Paper No. AER-55-16, by Louis Breguet.)

Shaft Drives for Airship and Airplane Propellers. General recognition of the possibilities of gear and shaft transmissions would free the designer from the limitations imposed by the fixed-unit power plant and appreciably broaden the field of aircraft design. Against these advantages are the weight and many engineering problems. The author discusses the most important problems from the standpoint of transmission design and suggests methods of meeting them. Working stresses, torsional vibration, dynamic balancing of long shafts, flexible couplings, and splines receive attention. (Paper No. AER-55-17, by J. L. Goldthwaite.)

Torsional Vibration of Aircraft Engine Crankshafts. Results of the study of torsional vibration of aircraft engine crankshafts are presented. Almost all engines have one or more easily detectable critical speeds for torsional crankshaft vibration. If one such critical speed should fall in the operating range of the engine, it is likely to cause trouble. Many apparently unrelated failures of engine parts can be traced to crankshaft vibration. It is therefore important that the vibration characteristics of every engine model be known so as to develop intelligently its design for maximum reliable power output. (Paper No. AER-55-18, by W. G. Lundquist.)

APPLIED MECHANICS

Stress Distribution in a Reentrant Corner. This paper deals with the stress distribution under plain strain in a corner of any angular magnitude, i.e., a plane with an angular incision or notch. It begins with a statement of Dr. Th. von Karman's method in his exact treatment of a beam in bending (Aachen Abhandlungen, Heft 7, 1927).

A generalization of this method is outlined which is applicable to the corner for any force distribution over the straight boundaries, and the solution is found for a concentrated load at any point of the boundary. The stresses are determined and shown to be infinite at the vertex of the corner.

The discussion points out the interesting paradox that stresses may be finite for certain continuous loadings, but become infinite if a portion of the load is removed. (Paper No. APM-55-6, by J. H. A. Brahtz.)

Concentration of Stress Around Spherical and Cylindrical Inclusions and Flaws. Solutions of the equation of elasticity are applied to investigate the disturbing effect of small spherical and cylindrical inclusions on an otherwise uniform stress distribution. Numerical results are found for gaseous inclusions (flaws), perfectly rigid inclusions, and for systems roughly representing slag globules in steel and reinforcing rods in concrete. (Paper No. APM-55-7, by J. N. Goodier.)

The Elastic Behavior of Vulcanized Rubber. Up to extensions of about 270 per cent the elastic behavior of vulcanized rubber can be represented analytically by a very simple function. The stress-strain diagrams for tension and compression are quite different; nevertheless this asymmetrical behavior is satisfactorily taken care of by employing only two elastic coefficients. (Paper No. APM-55-8, by H. Hencky.)

An Experimental and Analytical Investigation of Creep in Bending. This paper describes an experimental and analytical study of the phenomenon of creep as it occurs in bending. Creep tests upon a lead beam were made to determine the behavior of originally plane sections during pure bending accompanied by creep. From the results of these tests and of creep tests in tension and compression, a method is devised whereby the results of the usual tensile creep test may be utilized to predict the rate of creep for transverse sections of the beam. The paper concludes with several analytical examples involving creep as it occurs in pure bending. (Paper No. APM-55-9, by Gleason H. MacCullough.)

The Creep of Metals. In the following, a number of idealized cases of plastic flow of a more or less simple nature are discussed with primary intention of throwing light on how the speed of yielding influences the stresses under which metallic bars are permanently stretched or twisted at normal or at elevated temperatures. (Paper No. APM-55-10, by A. Nadai.)

Model Testing as Applied to Strength of Materials. This paper is primarily concerned with the effect of size on the ordinary strength properties of materials. The use of models in stress analysis is described briefly. The effect of size in tension, fatigue, and impact tests is considered in detail. Possible explanations for departure from the law of similarity are stated. (Paper No. APM-55-11, by R. E. Peterson.)

Applications of Creep Tests. Analytical solutions of problems which involve creep phenomena and which are of practical interest are at present very limited in number. This paper discusses four specific problems for which solutions have been presented: namely, the problem of the flanged and bolted pipe joint under creep conditions, and the three problems of stress distribution and creep in thick-walled cylinders under internal pressure, in a beam subjected to pure bending, and in a solid circular shaft under torsion. These solutions will illustrate the kind of creep data which the designer desires the experimenter to furnish. (Paper No. APM-55-12, by Gleason H. MacCullough.)

Factors Affecting Choice of Working Stresses for High-Temperature Service. This paper discusses the various methods which have been proposed to determine safe working stresses for high-temperature service. The question of the stability of alloys during the test and in subsequent service is considered, with particular emphasis upon probable changes in creep characteristics during long exposure to stress and temperature. It is shown that published data in general do not admit of extrapolation, and that attempts to estimate total creep in service from such data are not usually satisfactory. The author stresses the need for more fundamental study of the laws governing creep rather than creep tests of many different materials. (Paper No. APM-55-13, by P. G. McVetty.)

Notched-Bar Tests. In the present paper the author discusses the influence of such factors as temperature, width, and geometrical similarity in dimensions of specimens on the impact values as obtained by means of the notched-bar test. Various shapes of specimens for notched-bar tests are compared and their impact values determined. (Paper No. APM-55-14, by Max Moser.)

Theories of Strength. The conditions under which yielding starts at lower temperatures in metallic and also in other materials are discussed. Recent tests, particularly those made in England, Germany, Switzerland, and the United States, are compared and the results of a number of new ones concerning the conditions of yielding of steel are reported.

More detailed reference to these tests is made, and conclusions as to the best expressions available at present are drawn from them and utilized in rules for computing working stresses in practical cases. In conclusion, certain suggestions are made as to the conditions of ordinary rupture in a static test. (Paper No. APM-55-15, by A. Nadai.)

Working Stresses. This paper gives a general review of the fundamental aspects of the problem of strength and safety of machine parts. After an introductory discussion of the nature and scope of the problem, it offers suggestions for selecting working stresses for those conditions of applications of materials for which adequate knowledge is available. (Paper No. APM-55-16, by C. Richard Soderberg.)

Metals at High Temperature—Test Procedure and Analysis of Test Data. Tests on the flow of metals at high temperatures under stresses so small that the resulting distortions are less than one-tenth of 1 per cent show, throughout the duration of tests extending into the second year, continued reductions in rates of flow so that, for such small distortions, it is impossible to associate any particular rate of flow with a corresponding allowable stress. A statement of test results, to be of use, requires in addition to rate of flow and applied stress, certainly a record of total extension and possibly also a record of time elapsed. Furthermore, tests should be made under conditions of stress approximating the conditions of application in actual service. (Paper No. APM-55-17, by Ernest L. Robinson.)

HYDRAULICS

Progress in Hydraulics. There has been a fuller realization during the year reported upon of the importance of hydro in public-utility systems, as well as the dependence of hydro upon having such load systems to feed into. This emphasizes the interdependence of hydro and steam. Outstanding developments are referred to, such as the Rock Island Plant of the Puget Sound Power and Light Company and the Safe Harbor Plant in the East, where there are installed the most powerful Kaplan turbines in the world. Certain power companies have reported gratifying results from long-time forecasting of water supply by cyclic analysis. A laboratory designed especially for studying cavitation has been a helpful aid. Particular attention is being given to the economical operation of plants and to the simplification of power-plant design. Pumps, hydraulic laboratories and research, and electric motors are covered. (Paper No. HYD-55-1.)

A Study of the Data on the Flow of Fluids in Pipes. It was not until 1883, when Reynolds by dimensional analysis developed the equations for dimensional homogeneity and dynamic similarity, that any scientific basis for analyzing the experimental data on the flow of fluids was available. In view of the fact that only a small part of the experimental work previous to that of Stanton and Pannell has been reduced to Reynolds' dimensional basis, it was deemed desirable to undertake the present investigation in order to get a more complete knowledge of the flow problem, and in it an attempt was made to obtain all the data available on flow in pipes under pressure.

Some of the more important conclusions to be drawn from the data presented are:

1 The friction factor is independent of the fluid flowing for the same values of the Reynolds number R.

2 The friction factor for drawn brass pipe varies only ± 5 per cent from an average value and is substantially independent of the pipe size and fluid flowing for the same value of R within the range encountered in practise.

3 The friction factor for new steel pipe varies with the size, and varies about ± 10 per cent from an average value.

4 The data on used and artificially roughened pipes show that if the roughness is not large enough to cause contraction and enlargement losses, the friction factor never exceeds the value 0.054.

5 The mean hydraulic radius can be safely used as a criterion only in the turbulent region.

6 Special care should be taken in the selection or determination of the diameter. (Paper No. HYD-55-2, by Emory Kemler.)

Research Institute for Hydraulic Engineering and Water Power. This is a discussion of the paper by Hunter Rouse, Cambridge, Mass. [Trans. A.S.M.E., 1932] describing the large open-air hydraulic experiment station near Munich, Germany. (Paper No. HYD-55-3.)

PETROLEUM MECHANICAL ENGINEERING

Progress in Petroleum Mechanical Engineering. Oil and its products have been subjected to study for further economies. The report covers refining and the developments. Transportation progress for the year includes progress in gathering systems, electrical motor drive, pipe, fittings, Diesel engines, heat exchangers for closed cooling-water systems for Diesel engines, motor transport, welding, automatic pumping stations, metering of oil, and pipe-line bridges. In production practises there are included well-pumping equipment, bottom-hole pressure gages, use of tapered tubing, and hoisting equipment. (Paper No. PME-55-1.)

Heat-Transfer Design Data and Alignment Charts. A search was made, during a research program on heat transfer, for the best available methods for the prediction of heat-transfer coefficients and for means of simplifying design calculations. The equations selected or developed on film coefficients are given in the paper for gases flowing in turbulent motion inside tubes, for gases flowing across tube banks, for free convection outside horizontal cylinders and at vertical surfaces, and for condensing vapors. Alignment charts are given for the solution of these equations. A simplified method of designing gas-heat exchangers was worked out on the basis of one of the equations for the heat-transfer coefficient, and a chart is also given for pressure-drop calculations made in designing heat-transfer equipment. (Paper No. PME-55-2, by Thomas C. Chilton, Allan P. Colburn, Raymond P. Genereaux, and Harcourt C. Vernon.)

Semi-Luminous Flame Obtained With Heavy Domestic Fuel Oil in a Specially Designed Furnace. Some advantages of the semi-luminous flame for oil-burning furnaces are taken up in the early part of the paper. To assist in understanding some of the mechanics involved in obtaining the semi-luminous flame, the diagrammatic sketch, Fig. 2, labels a few of the happenings shown in Fig. 1. (The illustrations refer, of course, to those appearing in the complete paper.) Fig. 2 shows four main branches, A, B, C, and D, coming off from the flame. Each of these branches has in it several blocks labeled with some of the factors involved. Branch A deals with oil atomization, primary air, and initial chemical reactions. Branch B deals with secondary combustion air, final chemical reactions, etc. Branch C explains the thermal setting for proper flame temperature. Branch D takes up the specially designed steel boiler made necessary to coordinate properly the many factors involved (such as proper size and correct proportion of the combustion chamber) to obtain clean, quiet, efficient semi-luminous flame. (Paper No. PME-55-3, by P. L. Mikeska.)

Some Problems in the Lubrication of Vertical Journal Bearings. In deep-well pumping a motor at the surface drives a pump runner at the water level through a long vertical shaft supported at the top by a thrust bearing and guided at intervals of its length by journal bearings. For effective design the power absorbed by the journal bearings should be known approximately. The preponderance of horizontal shafts in various kinds of machinery has resulted in an extensive literature on their lubrication, but there is little that bears on the lubrication of such vertical shafts as are used in pumps, hydraulic turbines, a few steam turbines, cream separators, and centrifuges. The friction loss in these is small but in the deep-well pump the loss may be as great as 5 per cent of the power input. The paper relates the details of an investigation to establish some of the basic facts underlying the lubrication of vertical journal bearings such as are used in deep-well pumps. (Paper No. PME-55-4, by A. I. Ponomareff and E. D. Howe.)

CORRESPONDENCE

READERS are asked to make the fullest use of this department of "Mechanical Engineering." Contributions particularly welcomed at all times are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or comments from members of The American Society of Mechanical Engineers on its actvities or policies in Research and Standardization.

Accuracy of Heating Value Determinations

TO THE EDITOR:

Mr. Geo. A. Orrok, in his comments on fuel technology,[1] says that if bomb-colorimeter determinations do not check closer than 50 Btu, there must be something wrong with the method. I believe that it is not possible to get results that agree closer than 100 Btu; and in support of this claim I have had hundreds of identical coal samples tested by different commercial laboratories of reputable standing and have found that the results vary by more than 200 Btu in 90 per cent of the cases.

Furthermore, attempts to get closer results than these are superfluous refinements and altogether unessential. A variation of 200 Btu means an error of less than 2 per cent, and this is more accurate than are other values used in conjunction with it, as it is not possible to measure coal and water with errors of less than 2 or 3 per cent.

Many engineers carry their heat-balance calculations to four, five, and sometimes as high as ten significant figures when the accuracy of the measurements on which these calculations are based does not extend beyond the third figure. By carrying meaningless figures, engineers waste their own time and the time of their readers in trying to separate the essential from the non-essential.

N. T. PEP.[2]

Chicago, Ill.

Wages and Prosperity

TO THE EDITOR:

One of the principal long-term reasons for the failure of total wage payments to increase with the industrial production and profits is the system of fixed wages. It is true that wages are not fixed indefinitely, but they are not directly related to profits and production. Wages tend to rise during a boom, but during the last boom they failed to go up in proportion to the value of goods being sent to market. The point is that there is no direct connection between the level of wages and the level of commercial activity. Wages are the result of custom, the supply and demand for labor, and the negotiations between employers and employees. During the last boom there is no doubt that the rapid technical changes gave the advantage to the employer. Had it not been for these technical improvements, the increase in the production of consumers' and capital goods would have resulted in a shortage of skilled and unskilled labor, which would have brought about higher wages and in a way corrected the unbalance between the rate of investment and the rate of consumption.

It is now fairly clear that the problem of technological unemployment can be solved by proper adjustments of wages and working hours. The practical difficulty is that such technological changes cause unemployment, at least temporarily; and when, in a laissez-faire society, there is unemployment, there is no tendency for wages to rise. Therefore, any corrective measures must take the form of modifying the effect of supply and demand on wages and hours of work. Various nations, including our own, are attempting to work out methods whereby labor is no longer considered a commodity to be bargained for, and where these relations are to be altered in the statesmanlike desire to provide employment for all useful citizens. In this country such modifications have consisted principally of agreements of employers and groups of employers to observe certain minimum wage rates and maximum hours of labor. Without in any way criticizing these efforts, it is still questionable whether this is the ultimate solution, or whether some system of tying in working hours with production and wages with profits will not eventually be found more desirable than fixed wages and hours.

A FLEXIBLE WAGE SYSTEM PROPOSED

The system of having each employee work a fixed number of hours per day is in some ways undesirable. It would be better if the working hours were adjusted in proportion to the amount of work needed. In those industries where for technical reasons the working day cannot be varied, it would be possible to change the number of days per month. The psychological effect of laying off even a small proportion of workers is undesirable. A few men become unemployed, but many of those who remain become concerned about their employment and reduce their expenditures wherever possible. This may cause a further decrease in production and employment. On the other hand, if the working hours per month were adjusted to take care of minor changes in production, the workers would have a tenure of employment that would give them a considerable sense of security. They would know that a moderate slackening of industrial activity would reduce their incomes, but that they would have considerable assurance of employment. The mental effect of a small reduction of hours and of pay cannot be compared to that of a reduction of working force. Therefore, what might be called the psychological exaggeration of a decline in commercial activity would be greatly reduced, and a hundred men would not stop buying because five were laid off.

Even with a system of wage agreements between workers and employers, wages would not be automatically adjusted to give the purchasing power needed to keep industry on an even keel. There would be considerable lag between an increase in business activity and profits, and a corresponding increase in wage scales. The wage scales set by negotiations between workers and industries might not give the worker the purchas-

[1] Mechanical Engineering, October, 1933, pp. 645-646.
[2] Consulting Engineer. Jun. A.S.M.E.

ing power needed to keep up industrial activity, and conversely, the scales set up might be too high to be workable with the existing industrial and financial set-up. In this connection we might observe that the system of fixed time or straight piece wages is less desirable than those methods of pay where the rate per unit of work goes up with increased output per worker. Nevertheless, all the common systems of pay are defective in that they are not directly related to the level of industrial prosperity and profits.

Probably the simplest way to remedy the situation is to have the pay of workers and small-salaried employees depend partly on the profits of industrial corporations, or of groups of corporations in the same industry. Under such a system the pay would be made up of a moderate base rate and a bonus based on profits. It could be adjusted so that the workers' share in profits was small as long as the profits did not exceed some agreed reasonable point, but above that point the workers' share in additional profits would increase rapidly. This would make the purchasing power of workers and salaried employees go up automatically with prosperity, so that producers and sellers would not have to use the dangerous expedient of advancing additional credit to consumers in order to sell an increased output. Wages in normal times are one of the most actively circulating mediums in our financial structure. The average worker lives well below the standard he desires, and there are many things he wants to buy but does not feel he can afford. Therefore, it is probable that the major part of any increase in wages due to profit-sharing would soon return to the market for consumers' goods. This is particularly true if the workers' employment is protected by an arrangement of flexible working hours. Such an arrangement of flexible hours and wages would give us a more direct connection between production and consumption than we have at present, and would tend to stabilize industrial conditions.

From the standpoint of the employer, this system of flexible wages and hours would have several distinct advantages. From the production standpoint, it would have the effect of building up and preserving a skilled and experienced body of employees, familiar with the production tools and methods in use. When production increased, it would not be necessary to break in new men unfamiliar with the work. The flexible wage system has also a great advantage to the factory owner: although under such a system wages may be very high, these high wages are only paid when earned. There is no possibility of a wage level that will strangle the industry in the competition for markets.

This proposal to have wages change automatically with profits is revolutionary without being radical. It reverses the established custom of a hundred years of factory production, yet it does not alter radically our economic structure. Although it appears to be a radical innovation, it is really nothing new; the guilds of earlier days used a similar system. Many concerns pay executives and other officials on such a system. And we can find scattered through our industrial system many concerns that have wage systems of a similar nature. The principal example is probably that of some of the Western copper mines, which paid on a sliding scale based on the quoted price of copper. Some few concerns have had direct profit-sharing agreements in use for a long time.

DISCUSSION OF OBJECTIONS TO FLEXIBLE WAGE SYSTEM

There are several possible objections to the flexible wage system. The first is that it makes the workers' income somewhat uncertain in amount. It is held, quite reasonably, that it should be our aim to make stable the incomes of an ever-increasing part of our population, to get away from fluctuations in consumption. This may be entirely true, but it may be a more ideal condition than we can hope for at present. Due to changes in physical resources, technical equipment, type and variety of consumers' goods, styles, and buying habits, industry and commerce are always in a ferment. It is better to accept these shifts in industry and trade as inevitable (and in fact highly desirable for technical progress), and to overcome their bad effects by putting as much of society as possible on an income basis that moves with production. This would tend to continue the high level of production and employment during prosperous times, and would act to prevent the excess of capital goods over the needs of consumption.

Another objection that will be made to profit-sharing wages will be that all the profits should go to the owners, since they are the risk takers. A little thought will show us that this argument is incorrect. The worker also takes many risks in industry. In the first place, he risks unemployment and the total loss of his income. A person who owns even two shares of stock can divide his risks between two different industries, and can thus obtain a diversity that no worker can hope to equal. We need think only of the condition of the present unemployed workers to realize that stockholders are not the only ones who take risks in industry. The worker also takes a risk when he spends time learning a skilled trade, an investment in skill which may be wiped out by a technological change. He also takes a considerable health and accident risk in certain industries. The argument that all the profits should go to the owner or investor does not bear careful analysis. And it is also quite possible that a nation with flexible wages would be one with greater economic stability, which would directly benefit the investor of capital.

A more practical objection to flexible wages is that the income of workers in different factories would not be uniform, as it cannot be expected that the profits of all concerns will be similar. This objection is valid, although we must remember that wages throughout industry have not been uniform in the past. Nevertheless, the equalizing of wages of workers in different factories in the same industry is one of the problems of flexible wages. There are two possible ways of overcoming this difficulty. The first is to have the base pay make up the greater part of the wage, and have the bonus paid only when profits are above a normal rate. The result of this would be that the flexible wage would act only as a safety valve to distribute excess profits, and to a certain extent would reduce the value of wages based on profits. The other possible method is for wages in an industry to be based on the average rate of profits in that industry; or else an association of workers could pool all bonus payments, and divide them on a pro-rata basis. This again is open to several objections. In the first place, the exact accounting and mechanism of dividing and distributing profits in this way might be awkward and difficult. In the second place, factory managers would feel that the flexible wages would act as incentives to employees, and that the value of these incentives would be lost if the bonus were not based on the profits of individual concerns. Possibly this matter could be arranged on some compromise basis, such as having the wage rate depend partly on the general price level of the products of the industry and partly on the profits of the individual concerns. It is obvious that any such arrangement will be much simpler if the present and proposed industrial associations under the National Recovery Act are to be permanent institutions.

ADVANTAGES OF FLEXIBLE WAGE SYSTEM

The flexible wage has advantages for both capital and labor. From the worker's standpoint, it provides that he shall share,

directly and automatically, in industrial prosperity. From the standpoint of capital, it makes it impossible for wages to be set at a higher level than is justified by the existing level of business activity and prices, a provision which is absent from many of the other plans for industrial recovery. From the standpoint of our national economy and well-being, it insures that the wage fund, which is the purchasing power of a large and important group of consumers, will increase more or less in proportion to the value of the goods sent to market. It is plain that a system of wages based on profits has many attractive features. In the current discussions of recovery and economic stability it has not received the attention it deserves, and it should be seriously considered as one of the means of giving our economic system more stability, without making radical changes in our economic structure.

MORRIS P. TAYLOR.[3]

Cambridge, Mass.

Drip Condensation

TO THE EDITOR:

In the July, 1933, issue of MECHANICAL ENGINEERING is an article by F. A. Max Wulfinghoff entitled, "Drip Condensation," in which two illustrations are given which are taken from an article by me and my co-workers. While my name is mentioned in the text of the article, it is not indicated that the two illustrations are taken from our work.

E. SCHMIDT.[4]

Danzig-Langfuhr, Germany.

A.S.M.E. Boiler Code

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Below are given records of the interpretations of this Committee in Cases Nos. 761 and 762 as formulated at the meetings of October 20, 1933, all having been approved by the Council. In accordance with established practise, names of inquirers have been omitted.

CASE NO. 761

(Interpretation of Spec. S-17)

Inquiry: Subcommittee A-1 of the American Society for Testing Materials has approved a tentative revision of Par. 17 of Specifications A-83 for Lap-Welded and Seamless Steel and Lap-Welded Iron Boiler Tubes (identical with Specifications S-17) for marking short lengths and sizes of boiler tubes as follows:

17. *Marking.* *a* The name or brand of the manufacturer, the grade of material from which it is made, whether seamless or lap-welded, and whether steel or iron, and together with the hydrostatic pressure in pounds at which it was tested, shall be legibly stenciled on each tube $1\frac{1}{4}$ in. in outside diameter and over, provided the length is not under 3 ft.

b On tubes less than $1\frac{1}{4}$ in. in diameter and on all tubes under 3 ft. in length, the name or initials or brand of the manufacturer shall be legibly stenciled or indicated on a sticker applied on each tube.

Pending revision of Specifications S-17 to agree with the revision of A-83, will it be satisfactory to mark such small tubes in accordance with the tentative revision?

Reply: It is the opinion of the Committee that tubes marked in accordance with the tentative revision of Specifications A-83 will be satisfactory for acceptance under Specifications S-17 pending revision of that Specification.

CASE NO. 762

(Special Rule)

Inquiry: The special committee appointed at the March, 1932, meeting to consider the use of higher tensile strength plate for fusion welding of drums or shells of power boilers, has reported recommending the use of high tensile strength carbon steel plates under A.S.T.M. Specifications for High Tensile Strength Carbon Steel Plates for Pressure Vessels (Plates 2 in. and under in thickness) A149-33T, and for High Tensile Strength Carbon Steel Plates for Fusion Welded Pressure Vessels (Plates over 2 in. up to and including 4 in. in thickness) A150-33T. Will it be acceptable to construct riveted or fusion welded Code boilers or pressure vessels of material to Specifications A149-33T and fusion welded boilers or pressure vessels to Specifications A150-33T?

Reply: These tentative A.S.T.M. specifications have been accepted for addenda to the Material Specifications Section of the Code, and it is the opinion of the Committee that pending final action on these addenda, boilers and unfired pressure vessels constructed of material conforming thereto will be acceptable under the Code rules.

A Few Annual Meeting Papers Available

A VERY limited number of copies of preprints of a few 1933 A.S.M.E. Annual Meeting papers are available and will be sent on request as long as the supply holds out. Address requests to the A.S.M.E., 29 West 39th Street, New York, N. Y.

The following papers are available:

R. C. H. HECK, "A Review of the Pressure-Temperature Relation."

T. A. SOLBERG and ROBERT C. ADAMS, Jr., "A New Boiler-Water Treatment for the United States Navy."

W. J. ALBERSHEIM, H. S. KONHEIM, and C. M. LARSON, "Errors and Corrections in Viscosity Measurement."

H. D. HARKINS, "Interchanging Steam and Electric Power."

MAX B. HIGGIN, "Transfer Rates on Condensing, Reboiling, and Miscellaneous Heat Exchange Services."

P. NICHOLLS and W. T. REID, "Slags From Slag-Tap Furnaces and Their Properties."

Report of Committee on Power-Plant Betterment.

Multigraphed copies of Progress Reports of the following A.S.M.E. Professional Divisions are also available: Aeronautics, Fuels, Management, Machine Shop Practice, Oil and Gas Power, Petroleum, Railroad, and Textiles.

[3] Jun. A.S.M.E.

[4] Machine Laboratory, Technical High School of Danzig.

The A.S.M.E. Annual Meeting

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That afternoon also the editing committee of the Sectional Committee on the Standardization and Unification of Screw Threads completed its work on the revision of the present American National Standard for Screw Threads originally approved and published in 1924.

SAFETY

The activity in the field of accident prevention began with a luncheon meeting of the A.S.M.E. Safety Committee on Wednesday. J. E. Long, Superintendent of Safety, Delaware and Hudson Railroad Company, and this year's president of the National Safety Council, who had addressed the morning Management Session, was entertained as a guest and all five members of the committee were present. The new member of the Safety Committee is Harold L. Miner.

CODES

In the afternoon of the same day a meeting was held by the Sectional Committee on a Code for Pressure Piping of which E. B. Ricketts is chairman. At this meeting the combined Code, comprising six sections, which had been set up in page-proof form and distributed to the members of the committee prior to the meeting, was revised in detail. Certain revisions were agreed upon and the revised code was ordered to vote by letter ballot of the Sectional Committee membership.

RESEARCH

The attendance at Society research-committee meetings and the interest shown in their activities was better than last year. Fifteen meetings were held, attended by 195 men. In addition, seven of the committees contributed 20 papers and reports to the technical sessions of the Annual Meeting.

W. H. Fulwiler, the energetic and able chairman of the Main Research Committee for the past two years, retired on completion of his term. Alex D. Bailey, of Chicago, succeeds him. A brief review of what transpired at the meetings of the special and joint research committees is of interest.

New experimental data on discharge coefficients for orifices was reported before largely attended meetings of the A.S.M.E. Fluid Meters Research Committee and the Joint A.G.A.-A.S.M.E. Research Committee on Fluid Flow.

The Joint Boiler Feedwater Studies Committee made a critical review of its activities and decided to suspend study of water analysis methods at the University of Michigan after June 1 until further financial support is provided. Satisfactory progress was reported however by the subcommittee investigating alkalinity and sulphate relations in boiler water salines at the Non-Metallic Minerals Station of the Bureau of Mines.

The annual steam-table session was held as usual by the Research Committee on the Thermal Properties of Steam. Its experimental program, which has been in progress for the past twelve years, will be completed this year.

The Research Committee on the Cutting of Metals sponsored a technical session and metal-cutting demonstration in connection with the Taylor Celebration at Stevens Institute of Technology. Plans were announced by the committee for an experimental program at the Institute.

Prof. M. F. Sayre, of Union College, presented a final report of his investigation for the Mechanical Springs Committee on the elastic behavior of spring materials. Dr. D. J. McAdam, Jr., of the Bureau of Standards, presented a new instalment of his monograph for the committee on the fatigue and mechanical properties of spring materials.

The need for more information on the impact resistance of metals when subjected to high temperatures and stresses over long periods was brought out by the joint A.S.T.M.-A.S.M.E. Research Committee on the Effect of Temperature of the Properties of Metals.

The annual meeting of the Condenser Tube Committee attracted a large attendance and there was lively discussion on several subjects related to tube life. The committee adopted a resolution urging that the Council make every effort adequately to support the Society's research activities next year.

The Lubrication Research Committee voted to support financially experimental work on viscosity of oils at high pressures at Harvard University under Dr. P. W. Bridgman and on surface wear at the University of Michigan under Dr. S. Timoshenko.

Because it has not been able to accomplish useful results, the Committee on Diesel Fuel Oil Specifications voted to disband.

POWER TEST CODES

The usual quarterly meeting of the Power Test Codes Committee was held this year on Friday morning. It was well attended and a considerable amount of routine business was transacted. Prof. R. H. Fernald presided in Chairman Low's absence. Twenty-seven attended this meeting and the most important announcement which was made was to the effect that the revision of the Test Code for Reciprocating Steam Engines was now in printer's proof form. Subcommittee on Fans of P.T.C. Committee No. 10 on Centrifugal and Turbo-Compressors and Blowers met on Wednesday afternoon and P.T.C. Committee No. 18 on Hydraulic Power Plants held an all-day session on Thursday.

Industrial Management and the Recovery Program

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far and wide, will slowly discover some of their feeding grounds in local markets dried up or preempted by smaller animals, swifter moving and closer to the ground. In these ways the energies of economic growth will gradually be withdrawn from their great creations—the industrial dinosaurs and commercial mammoths—of the past and make a fresh start in a small way in many scattered individuals. Thus beneath the dead rigid structure of the centralized collective economic system a new indigenous economic life will spring up, and the beginnings of the decentralization and diffusion of our economic energies toward which we are tending beneath the surface, as the ultimate outcome of the electric power age, will appear.

In conclusion, there is every reason to expect that our progress toward collectivism under the recovery program will supply our planners with plenty of unanticipated and puzzling problems and industrial management with plenty of unexpected excitement which will enliven the economic and political scene for some time to come. It would be too much to expect, however, that industrial management as we know it today will mobilize its own intelligence, and organize its own instruments of realistic insight to inform itself fully of what is happening and to understand in a detached and disinterested way the implications of the process in which it is cooperating, so long as it is itself under the spell of the powerful old delusions that underlie the New Deal.

Books Received in the Library

AN ENGINEER'S OUTLOOK. By Sir A. Ewing. Methuen & Co., Ltd., London, 1933. Cloth, 5 × 8 in., 333 pp., diagrams, 8s 6d. The papers and addresses that form this volume will be read with interest, both for the views of the distinguished author and for his delightful style. Among the contents are interesting character sketches of Lord Kelvin, Sir Charles Parsons, Fleeming Jenkin, R. L. Stevenson, and Lord Balfour. Others discuss the relation of science to modern problems, invention during the last century, power and magnetism. The preface is a charming brief biography.

FORSCHUNGSHEFT 361. Strömungsgesetze in rauhen Rohren. By J. Nikuradse. V.D.I. Verlag, Berlin, 1933. Paper, 8 × 12, 22 pp., illus., charts, diagrams, tables, 5 rm. The purpose of this investigation was to study the effect of various degrees of wall roughness upon turbulent flow in pipes, for any Reynolds numbers, and to determine the laws governing resistance and velocity. The research work is described in detail and discussed fully.

INDUSTRIAL HEAT TRANSFER. By A. Schack, translated from the German by H. Goldschmidt and E. P. Partridge. John Wiley & Sons, New York, 1933. Cloth, 6 × 9 in., 371 pp., diagrams, charts, tables, $5. The aim of this book is to supply simple formulas or graphs, where simple formulas are not available, which will enable the engineer to deal with problems of furnaces and heat exchangers. The work is based upon the author's experience, covering seven years, as investigator of heat-transfer problems at the heat institute of the Verein deutscher Eisenhuettenleute, and is markedly thorough and practical. The translators have provided an excellent translation, in which all equations have been converted to English units. A useful bibliography is included.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN DES GHH-KONZERNS, Vol. 2, Part 7, August, 1933. (1) Strömungsvorgänge in neuzeitlichen Dampfturbinen, by S. Hofer. (2) Der Druckluftwalzenmotor, eine neue Antriebsmaschine, by K. Pöll. (3) Fortschritte im Zahnradgetriebebau, by W. Lindner. V.D.I. Verlag, Berlin, 1933. Paper, 9 × 12 in., 2.45 rm. This pamphlet contains three reports from the research departments of German industrial concerns. The first discusses steam flow in modern turbines. The second describes a new type of rotary compressed-air motor for use in mines. The third discusses new developments in gearing.

DIE PHYSIKALISCHE CHEMIE DER KESSELSTEINBILDUNG UND IHRER VERHÜTUNG. Sammlung chemischer und chemisch-technischer Vorträge. Second edition. Part 3. By R. Stumper. Stuttgart, Ferdinand Enke, 1933. Paper, 7 × 10 in., 74 pp., illus., charts, tables, 5.30 rm. The formation and prevention of boiler scale are discussed in the light of the principles of physical chemistry. This edition has been enlarged and partly rewritten to include recent investigations, especially upon silicate scales, the solubility of scale formers at working temperatures, the colloidal chemistry of scale preventatives and the dynamics of carbonate scale formation.

SYMPOSIUM ON MOTOR LUBRICANTS. American Society for Testing Materials, Philadelphia, 1933. Paper, 6 × 9 in., 121 pp., charts, tables, $1.50. Seven papers presented at this symposium are given, with the discussions they provoked. The subjects included carbon deposits, service requirements, oil consumption, the effects of engine design, changes during use, etc.

SILHOUETTES OF ROYAL AIR FORCE AIRCRAFT. (Air Publication 1480), March, 1933. His Majesty's Stationery Office, London (British Library of Information, New York). Paper, 6 × 8 in., diagrams, 1s 3d. Silhouettes of all the different types of aircraft used by the Royal Air Forces are given, to facilitate their recognition. Front, side and bottom views are provided, all drawn to one scale.

VALUABLE HINTS TO INVENTORS. By A. F. Gillet. Inventors Publishing Co., Washington, D. C., 1933. Cloth, 5 × 8 in., 94 pp., $1. Seven addresses by the chairman of the Technical board of the International Association of Inventors, discussing such matters as how and what to invent, how to make patented inventions pay, etc.

VOCATIONAL GUIDANCE IN ENGINEERING LINES. Edited by the American Association of Engineers. Mack Printing Co., Easton, Pa., 1933. Cloth, 6 × 9 in., 521 pp., illus., charts, $2.50. The aim of this book is to be "a simple, practical yardstick by which those young men who aspire to be engineers can measure their natural fitness for the tasks imposed by the profession, their ability to content themselves with its probable rewards, and the intensity of their own desires to join the ranks of the Sons of Martha." Chapters upon every important branch and specialty of engineering, each by a well-known practitioner, give an unusually accurate and complete picture of the whole field. In addition such general subjects as engineering ethics, idealism in engineering, vocational guidance and aptitude tests are discussed.

WHAT'S GOING ON

New Members of the A.S.M.E. Technical Committees

THE members of the A.S.M.E. Standardization Committee are happy to announce the appointment of Walter Samans, chief engineer, Atlantic Refining Company, Philadelphia, Pa., by President Doty to the Committee for the five-year period 1933–1938. Since 1920 Mr. Samans has been a member of the Society and has been active in its committee work, having served as a member of the Executive Committee of the Petroleum Division, and as a member of the Sectional Committee on the Standardization of Pipe Flanges and Fittings representing the American Petroleum Institute.

Mr. Samans is Chairman of the Joint A.P.I.-A.S.M.E. Committee which is developing Rules for the Design, Construction, Inspection, and Repair of Unfired Pressure Vessels for Petroleum Liquids and Gases. Other society memberships held by Mr. Samans in addition to that in the A.S.M.E. include the American Society of Civil Engineers and the American Petroleum Institute.

H. L. MINER APPOINTED TO SAFETY COMMITTEE

The members of the Standing Committee on Safety believe that the membership of the Society will be interested in learning of the appointment of Harold L. Miner, Manager, Safety and Fire Protection, E. I. du Pont de Nemours & Co., Wilmington, Del., to the Committee for the five-year term beginning December, 1933. Mr. Miner has been a member of the Society since 1917 and has taken an active part in the safety movement in the United States.

POWER TEST CODES APPOINTMENTS

Being a standing Committee of twenty-five members, one-fifth of the members of the A.S.M.E. Power Test Codes Committee terminate their membership each year. To fill the vacancies this year President Doty has named the following members of the Society:

Hans Dahlstrand, mechanical engineer, steam turbine engineering department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.; Louis Elliott, consulting mechanical engineer, Electric Bond & Share Company, New York, N. Y.; George A. Horne, vice-president and chief engineer, Merchants Refrigerating Company, New York, N. Y.; Herbert Reynolds, mechanical engineer, Interborough Rapid Transit Company, New York, N. Y.; and Edward N. Trump, Trump Corporation, Syracuse, N. Y.

A Tenth-Century Book on the Handicrafts

A BEAUTIFULLY bound and printed book, of great interest to students of the history of technology, was recently presented to The American Society of Mechanical Engineers by the Verein deutscher Ingenieure. The book, which is entitled "Technik des Kunsthandwerks im Zehnten Jahrhundert," is a translation into German of a Latin text on the handicrafts of the tenth century. A translation of the letter accompanying the book reads as follows:

"The Verein deutscher Ingenieure extends to The American Society of Mechanical Engineers its best greetings and wishes for a successful annual meeting, with beneficial results to engi-